ADOLESCENT HEALTH: TIME FOR A CHANGE

Volume 3: Contractor Documents

1. "Adolescent Dental and Oral Health" by Paul S. Casamassimo, DDS, MS.
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by Paul S. Casamassimo, DDS, MS

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Comments should be sent to:
Denise Dougherty, Ph.D.
Project Director for Adolescent Health
Health Program
Office of Technology Assessment
U.S. Congress
Washington, D.C. 20510

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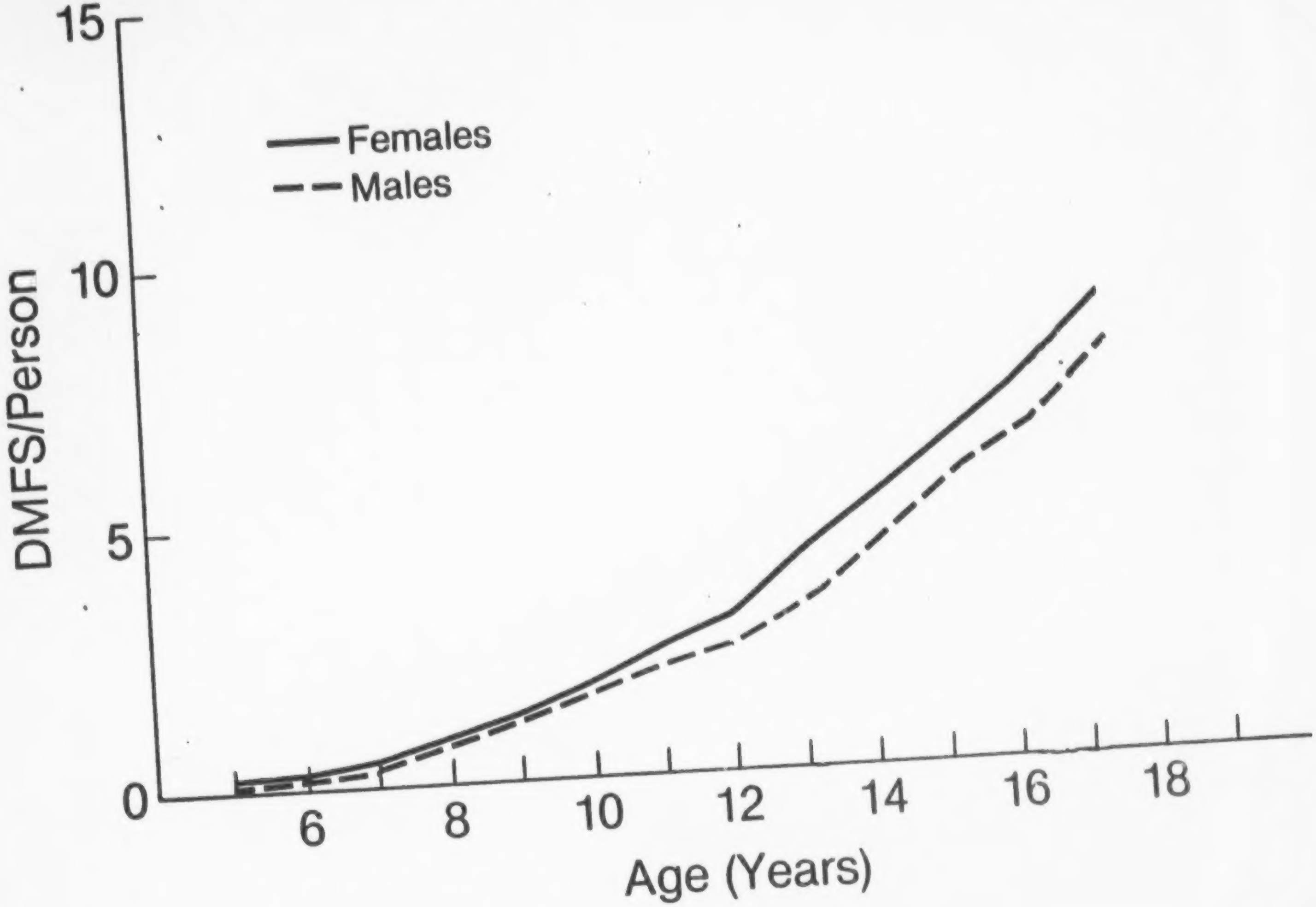
ADOLESCENT DENTAL HEALTH

INTRODUCTION

Children in this country reach adolescence having had the benefits of one of the best dental care systems in the world. For most children entering teenage, dental caries is not a problem, periodontal conditions are minor and transitory, and most orthodontic problems do not have a significant impact on health. These children have had the benefits of fluoridated community water, widespread availability of fluoride-containing dentifrice, improved access to dental services, and education about dental health. For some adolescents, however, the outlook for early adulthood is less favorable. Many children still enter adolescence with dental caries. Preliminary data on dental caries in children from the National Institutes of Health show 12-year-olds with a caries rate of about 3 decayed missing or filled surfaces (DMFS). Seventeen-year-olds in this 1986-87 study had a DMFS rating of about 8 (U.S. DHHS, HHS News, 1988) (See Figure 1.). Malocclusions of various types and severity also remain untreated due largely to a lack of payment mechanisms. Periodontal disease becomes an irreversible problem in this period, and while recent adult data from national studies show an improved picture for periodontal health

Prevalence of Dental Caries by Age & Sex, 1986-87



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in later life, some teenagers are needlessly afflicted with gum problems which can only be treated by professional care.

Important issues such as variances in dental disease patterns and care seeking by various socioeconomic and racial groups, negative effects of habits like smokeless tobacco, traumatic injury to teeth, transition from childhood to consenting adulthood and responsibility for care, and unmet orthodontic needs make adolescence a pivotal period in one's dental health.

The recent history of adolescent dental health care has roughly paralleled that of general adolescent health with a resurgence in interest in the last decade. The popular and professional media have emphasized smokeless tobacco use, orthodontic treatment, effects of bulimia, and the decrease in dental caries. Many dental professionals continue to believe that adolescence is a quiescent period, a continuation of childhood, with few dental needs if orthodontic care is not a consideration. Dental research only recently has addressed some issues related to adolescent dental health--juvenile periodontitis, smokeless tobacco, and attitudes on dental health.

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The lack of emphasis on teenage in dentistry is a paradox considering these factors:

- Dental caries increases in amount and rate during adolescence (Casamassimo, 1982).
- The first signs of irreversible periodontal disease occur in teenage (Casamassimo, 1979).
- Up to a third of facial growth occurs in early teenage during a relatively short growth spurt (Graber, 1969).
- Most orthodontic therapy occurs during adolescence.

For the last 3 decades, treatment of dental caries in the primary and early mixed dentition predominated dentistry. Similarly, public health programs aimed at the younger population with the belief that early intervention had both immediate and long-term benefits. Adolescence became a period of life through which earlier dental intervention carried the patient to adulthood in good health.

This chapter describes the dental health issues for adolescence, beginning with physiologic and anatomic changes that affect the oral cavity and the prevalence of dental disease in this age group. The adolescent has or acquires risk factors for dental disease and these are

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discussed as well as their utilization of dental services. Finally, programs promoting or detailing dental health needs are presented and a summary of implications and recommendations are enumerated.

ADOLESCENT BODY CHANGES AND THEIR IMPACT ON ORAL HEALTH

Puberty is the hallmark of adolescence, and the physical changes which characterize teenage are mirrored in the oral cavity. Three areas seem to have particular importance for the adolescent from the standpoint of the oral cavity: immunologic maturation, skeletal growth, and hormonal change. By age 12, the dentition is usually stable. All primary teeth have been replaced with permanent successors; second or 12-year-old molars have erupted, and only the third molars remain to develop and erupt (Finn, 1973). Between the ages of 10 and 12 years, remaining primary molars and canines will have been lost. If one considers the number of primary teeth which are lost and those permanent teeth that erupt during a 2 to 3 year period, early adolescence is a dynamic time. Nature has timed the transition so that in a practical sense, orthodontic problems are rarely caused by this rapid turnover of teeth.

The impact of immunologic maturation is not well understood, but recent research suggests that the peaking

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of the immune system in late adolescence is tied to the beginning of irreversible bone loss from periodontal disease. Children with primary dentitions do not demonstrate gingival inflammation comparable to that experienced by adults with equivalent plaque (Cox, 1974). Inflammatory cell populations, possibly reflecting immune differences between children and young adults, differ in mature gingivitis in these 2 age groups. The gradually increasing Periodontal Index, a marker of periodontal health (Table 1), may in part be explained by the gradual maturation of the immune system during adolescence and the teenager's increased risk of periodontal destruction. It is interesting to note that oral hygiene scores do not correlate well with the increasing Periodontal Index, thus emphasizing the changing relationships in gingival health in the adolescent (U.S. DHEW, 1974).

Skeletal growth during adolescence is well-described in dental literature but remains a somewhat unpredictable and poorly controlled variable with clear implications for orthodontic treatment. The face grows significantly during adolescence, completing almost all its vertical growth in this period. Variations in growth, lack of it, or variable rate of growth all affect tooth position, facial contour and space available for

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Table 1.--Periodontal Index (PI) and Simplified Oral Hygiene Index (OHI-S) for Adolescents 12 to 17 Years of Age

Age (Yrs)	PI Score	OHI-S Score
12	0.27	0.94
13	0.28	0.92
14	0.32	0.90
15	0.33	0.87
16	0.33	0.86
17	0.36	0.82

SOURCES: U.S. Department of Health, Education and Welfare, Public Health Service, National Center for Health Statistics, Periodontal Disease Among Youths 12-17 Years, DHEW Pub. No. (HRA) 74-1623, (Washington, DC: U.S. Government Printing Office, 1974).

U.S. Department of Health, Education and Welfare, Public Health Service, National Center for Health Statistics, Oral Hygiene Among Youths 12-17 Years, DHEW Pub. No. (HRA) 76-1633, (Washington, DC: U.S. Government Printing Office, 1975).

teeth (Ranly, 1980). Orthodontic treatment must account for growth during this period. Unfortunately, no precise predictor of growth exists at this time and while it can be tracked and extremes identified, useful tools to help plot an adolescent's final orthodontic status remain elusive (Casamassimo, 1988). Bone composition changes in adolescence as well, resulting in a more calcified facial skeleton. Extractions in teenage and early adulthood are often complicated by osteitis, an extremely rare occurrence in younger children.

Finally, hormonal changes seem to affect the susceptibility of adolescents to gingival problems. The interaction between local irritating factors like plaque and calculus and hormones is known to exist but, like other aspects of adolescent dental health, is poorly understood. Studies have documented the role of hormonal change in gingival conditions in adolescents (Sutcliffe, 1972), but treatment of these conditions remains non-specific. Since most of these are transitory and of minor severity, research to develop explanations about hormonal-environmental interaction probably will be slow to occur.

ADOLESCENT BEHAVIORS AND THEIR IMPACT ON ORAL HEALTH

A variety of infrequent but potentially

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troublesome oral conditions arise out of adolescent behaviors, not the least of which is a tendency to ignore personal dental hygiene practices. Table 2 identifies a variety of adolescent and young adult activities and behaviors and their effect on the oral cavity. Many are infrequent in nature but result in long-term damage to oral structures when they occur. Others are more frequent but with minor or reversible effects. An example of a frequent but prevalent behavior with long-term consequences is smoking. Smokeless tobacco use, on the other hand, is a frequent but less prevalent behavior, but one with both short- and long-term consequences of some significance to the adolescent.

The dental profession's lack of emphasis on teenage oral health makes some of these less frequent behaviors a problem in that many will go unnoticed or unaddressed. Only recently has organized dentistry publicized the role of dentists in identifying societal health issues like drug abuse and smoking (McCann, 1989). It is interesting to note that adolescence has been overlooked as a focal point for instituting long-term dental health behaviors. Little research has addressed the nature of adolescent attitudes and behaviors as they affect dental health in this country. Applewhite (1974)

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Table 2.--Adolescent Behaviors With Potential Dental Effects

Behavior	Effects on Oral Cavity and Dentistry
Alcohol and Drug Use	Long-term use related to oral cancer; Short-term use complicates drug administration by dentists and office behaviors; dental neglect in addicted patients
Athletics	Traumatic injuries to teeth and jaws
Bulimia	Periodontal problems and acid destruction of teeth from vomiting
Oral Contraceptives	Periodontal disease from hormonal change; Increased risk of dry socket after extraction
Pregnancy	Gingival inflammation
Sexually Transmitted Disease	Oral infections; HIV positivity affecting care delivery
Smokeless Tobacco Use	Short-term: Mucosal changes, staining of teeth; Long-term: Oral cancer risk increased, periodontal disease
Smoking	Same as for smokeless tobacco
Stress	Oral infection

SOURCE: Casamassimo, P.S., Bronstein, S.L., Christensen, J., et al., "Periodontal Disease and Temporomandibular Joint Disorders," Pediatric Dentistry, Infancy Through Adolescence, J.R. Pinkham, P.S. Casamassimo, H. Fields, et. al. (eds.) (Philadelphia, PA: W. B. Saunders, 1988).

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commented almost 2 decades ago that public health and treatment programs focused on younger children rather than adolescents, perhaps in the belief that behaviors and effects would carry over to adulthood. He makes the point that programs originally designed for younger children try to shape the behavior and health of adolescents rather than having these behaviors and health needs shape the programs. While health initiatives in drug treatment, adolescent pregnancy, delinquency, and venereal disease have focused on the teenager and his or her unique characteristics, those in dentistry have not.

DENTAL DISEASES OF ADOLESCENTS

The major dental diseases affecting all age groups are dental caries, periodontal disease, and malocclusion. Over the last 3 decades, changes in disease patterns have occurred, some dramatic. None is more dramatic than the drop in dental caries prevalence in the last 30 years. Malocclusion has undergone a transition from a condition created, to a significant degree, by premature tooth loss due to dental caries, to one that is largely inherited.

Additional conditions, far less frequent, also emerge in adolescence. Some, like localized juvenile periodontitis and puberty gingivitis (see Figure 2), are peculiarly adolescent in nature. These conditions can

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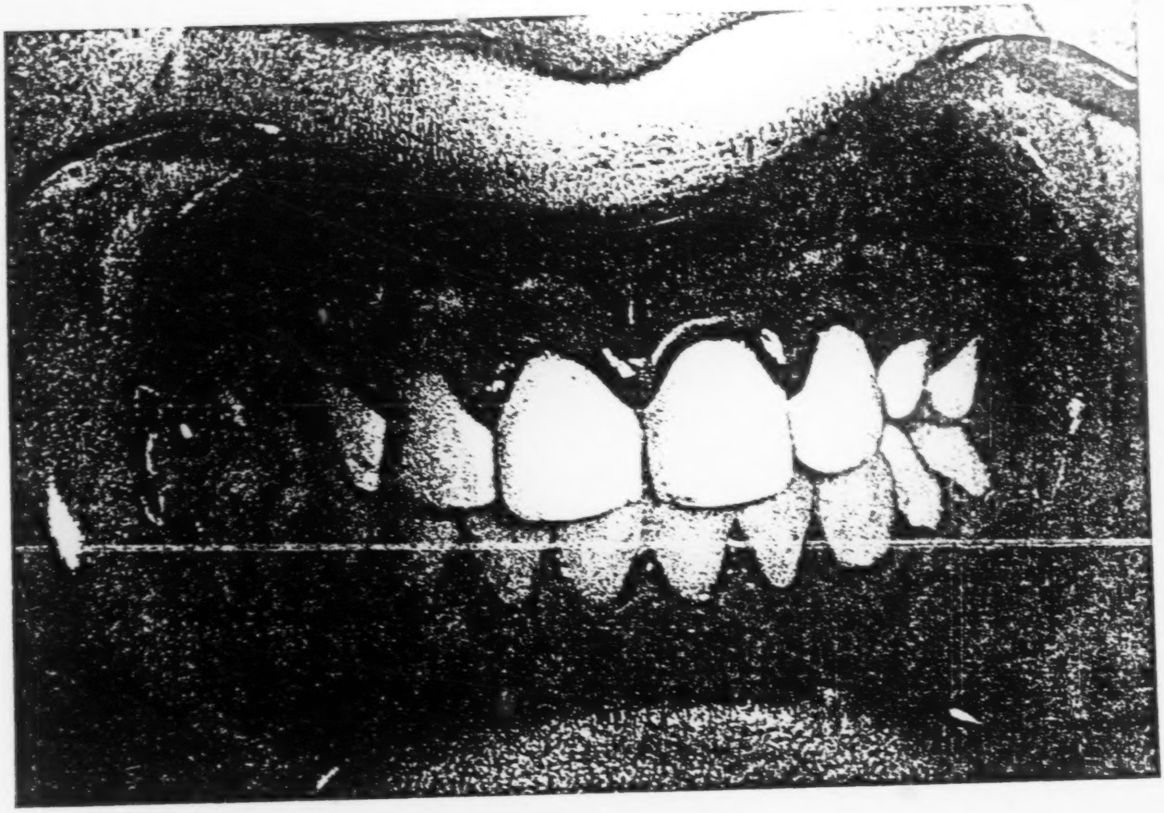

Figure 2..--Adolescent Gingivitis

Source: P. S. Cassamassimo, 1989.

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be infectious in nature, or neoplastic--several types of tumors occur with most frequency in adolescence.

Dental Caries

Dental caries affects all age groups and races. Far more is known today about this disease then even a decade ago. Dental caries is an infectious condition which requires a combination of a susceptible host, cariogenic bacteria, and a carbohydrate diet which, over an extended period of time (usually at least several months), leads to the decalcification of tooth structure by the acid produced by bacterial metabolism.

Dental caries ranges in severity from whitish decalcification of enamel to frank destruction of the tooth requiring a dental restoration, pulpal therapy, or removal of the tooth. The caries rates described in this report are for carious lesions requiring treatment. The studies cited use the decayed, missing and filled surface of tooth rating system (DMFS or DMFT), indicating how many of the surfaces of or how many permanent teeth require service or, as another indication of previous caries experience, have received a restoration or filling. The technique of examination is described in a variety of references (U.S. DHEW, 1971).

The data sources for the description of dental

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caries in adolescents is largely from national surveys performed under contract to the National Institutes of Dental Research. While these data attempt to describe caries experience in representative groups, they may not adequately portray the caries experience of particular groups with unique circumstances or risks. Some of these other reports are provided.

The most recent data on caries, obtained in 1986-1987, is not yet available except in abbreviated form. These data show a drop in caries of about 36 percent for all children 5 to 17 years of age. For children 10 to 17, the percentage decrease ranges between 20 and 40 percent (Figure 3), yet the number of DMFS per person increases from about 2 to 8. In the 1979-1980 survey, for which published data are available, the DMFS rate was about 11 (U.S. DHHS, National, 1981).

The rate of caries and the percentage of caries-free adolescents appear to be changing for the better. In studies done in the 1960s, the mean DMFT and percentage of children who were caries-free were 6.2 and 10.4, respectively (Table 3). In the early 1970s, the number remained about the same with 6.2 mean DMFT and 9.7 percent of 12-17-year-olds caries-free. By the 1979-1980 study, the mean DMFT had dropped to 4.6 and the caries-

Percent Decrease in Caries Prevalence by Age, 1980-1987

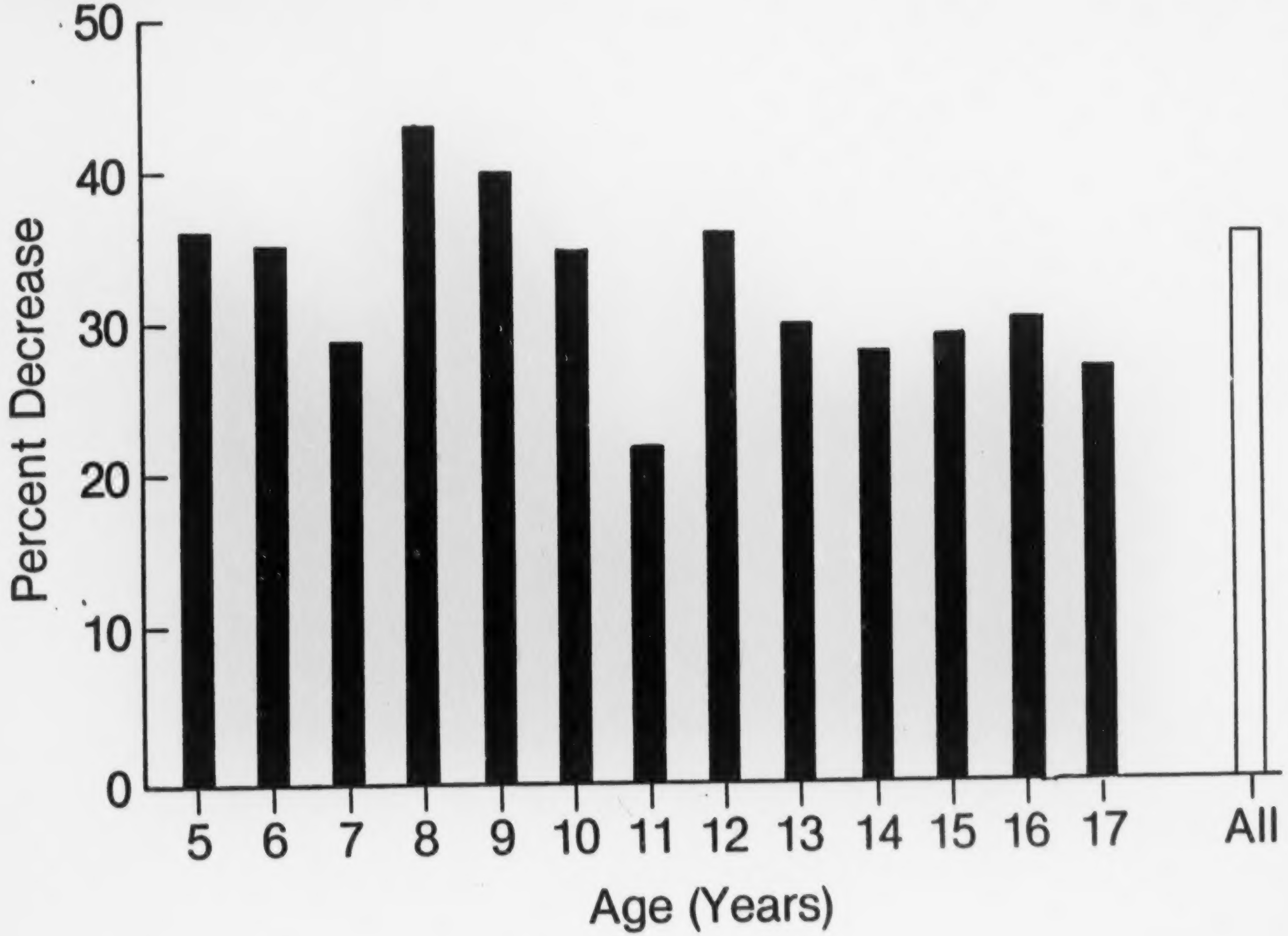

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Table 3.--Comparison of Mean DMFT Scores and Percentage of Caries-free 12-17-Year-Olds From Major U.S. Caries Studies

Status	NCHS	NCHS	NIDR
DMFT	6.2	6.2	4.6
Caries-free %	10.4	9.7	17.2

SOURCE: Adair, S.M., "Epidemiology and Mechanisms of Dental Diseases in Children," Pediatric Dentistry, Infancy through Adolescence, J.R. Pinkham, P.S. Casamassimo, H.W. Fields, et.al. (eds.) (Philadelphia, PA: W.B. Saunders, 1988).

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free percentage had increased to 17.2 percent.

The caries status of adolescents in 1979-1980 was improved over similar study groups from previous years. The mean DMFS and T scores for all 10-17-year-olds in 1979-1980 is shown in Table 4. DMFT ranged from 1.69 in 10-year-olds to 6.36 in 17-year-olds. Females had a slightly higher DMFT rate than did males at comparable ages. Blacks and others had a lower rate with a DMFT ranging from 1.45 at 10 years to 4.85 at 17 years of age.

Other measures of dental caries exist and provide an indication of severity. The DMFT rating is an indicator of caries prevalence but also tells the story of severity in its increments. In Table 5, the percentage of decayed, missing and filled increments for whites is compared to blacks and others. Several factors stand out in relation to untreated disease and the effects of disease. Although blacks and others had a lower DMFT at every age increment, their percentage of decayed (untreated caries) was consistently higher. In fact, for whites, the percentage decreased with age from 23.5 percent of total DMFT to 10.8 percent, while for blacks it remained essentially the same (35.2 at age 10 to 34.7 at age 17). The missing component also increases for blacks and others with age far more rapidly than for

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Table 4.--DMFS and DMFT for Children Aged 10 through 17 Years, From 1979-1980.

Age (Years)	Mean DMFS All	Mean DMFT All	Mean DMFT Female	Mean DMFT Male	Mean DMFT Whites	Mean DMFT Blacks
10	2.60	1.69	1.86	1.53	1.74	1.45
11	3.0	1.96	2.15	1.78	2.04	1.55
12	4.18	2.64	2.87	2.41	2.77	1.97
13	5.41	3.38	3.69	3.09	3.48	2.87
14	6.53	4.04	4.20	3.89	4.16	3.43
15	8.07	4.94	5.39	4.52	5.11	3.99
16	9.58	5.54	6.15	4.96	5.62	5.07
17	11.04	6.35	6.67	6.04	6.60	4.85

SOURCE: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, The Prevalence of Dental Caries in United States Children 1979-80, NIH Pub. No. 82-2245 (Washington, DC: U.S. Government Printing Office, December, 1981).

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Table 5.--Decayed, Missing and Filled Increments of the DMFT for Whites and Blacks, 1979-80

Age (Years)	Whites			Blacks		
	% D	% F	% M	% D	% F	% M
10	23.5	75.8	0.8	35.2	62.5	2.3
11	20.2	78.9	0.9	44.1	54.0	1.9
12	19.5	79.5	1.0	38.0	56.6	5.5
13	18.5	79.8	1.7	40.9	54.5	4.6
14	18.2	79.7	2.1	32.8	63.0	4.2
15	13.7	84.3	2.0	44.0	50.9	5.1
16	12.8	84.5	2.7	31.0	61.2	7.8
17	10.8	86.9	2.3	34.7	55.3	10.0

SOURCE: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, The Prevalence of Dental Caries in United States Children 1979-80, NIH Pub. No. 82-2245 (Washington, DC: U.S. Government Printing Office, December, 1981).

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whites (10.0 at 17 years for blacks and others as compared to 2.3 at 17 for whites). These data suggest that minorities experience less dental caries, but more of it remains untreated and leads to more serious consequences over the adolescent period and into adulthood.

Additional measures of the caries status of adolescents can be stated as treatment needed. Twenty-three percent of children age 10 years needed restoration of permanent teeth in the 1979-1980 national survey. When white 10-year-olds are looked at, the percentage drops to slightly over 22. Yet, when blacks and other non-white 10-year-olds are looked at, the percentage rises to over 28 percent. The need for restorations of teeth continues through age 17 years and increases to over 33 percent of all 17-year-olds. The variance between whites and blacks also persists in the need for restorations--over 30 percent of whites at 17 need permanent restorations, while almost half (49.2 percent) of blacks and others need them at age 17.

Tooth extraction and needed pulpal treatment of permanent teeth are 2 other measures of severity of dental disease and, to a great degree, dental caries. Trauma and other causes contribute to this measure as

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well, to some degree. Less than 1 percent (0.9) of all U.S. 10-year-olds need to have a tooth extracted for disease purposes, and only 1.3 percent need pulpal treatment of permanent teeth at this age. By 17 years of age, the percentage only increased to 3.3 for extractions and to 2.2 for pulpal treatment. This speaks to the minor involvement of caries in this age group.

The discrepancies between whites and minorities continue in these measures. White 10-year-olds needing tooth extractions are only 0.5 percent of their group; white 17-year-olds account for only 2.1 percent. Only 1.2 percent of white 10-year-olds need pulpal treatment of permanent teeth, and by age 17, this percentage increases only a tenth of a percent to 1.3.

Blacks and other minorities at age 10 need few permanent teeth extracted--only 2.8 percent of this age group--but by age 17, about 1 in 10 minority adolescents need a permanent tooth extracted from disease (10.4 percent). Pulpal treatment needs are, for blacks and other minorities, almost similar to that of whites at 1.8 percent at age 10. Unfortunately, by age 17, this increases to 6.9 percent (U.S. DHHS, 1982).

The replacement of a tooth or placement of a crown is also an indication of severity of disease. At age 10,

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1.1 children needed a tooth replaced; by age 17, 6.7 percent needed a permanent tooth replaced. For blacks and others, the numbers were slightly greater at age 10 (1.8 percent) but significantly greater at 17 years (17.9 percent). One in 6 minority teenagers needed a tooth replaced at age 17 years. Since the needs were about the same at age 10, this would indicate a lack of attention to care in the teen years which might have saved teeth. This assumption is supported by the information on need for crowns. At age 10, blacks and other minorities and whites are very close in needs--2.0 percent of whites have a permanent tooth requiring a crown, while 2.3 percent of minorities need crowns. By age 17, the discrepancy has increased. Only 3.5 percent of whites need a crown, while 10.8 percent of minorities do. It appears that the disease which does occur in minorities is often untreated and seems to lead to problems later on. Clearly, minorities contribute to the percentage of partially edentulous adults because of a lack of care in teenage, well beyond their proportional representation in the population (U.S. DHHS, 1982).

Other minority adolescents have been studied for dental caries prevalence, and their status against national data for all children is not heartening. In

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fiscal year 1983-1984, the Indian Health Service conducted a service-wide study of children and found that, overall, Native American children have twice the amount of dental caries. The mean DMFT rating for Indian 13-19-year-olds ranged from a low of 9.4 in southwestern Indian adolescents to a high of 12.7 in those from the northwest. The F component of the DMFT, an indicator of untreated caries, ranged from 50 to 77 percent (U.S. DHHS, Findings 1985).

From the standpoint of dental caries, it is safe to say that the caries rate is declining but that adolescents continue to have a moderate caries experience. Minority adolescents, especially those, it seems, who depend upon public programs for care, remain the groups with the most caries or most significant needs for the disease they have (Figure 4) (Backinger, 1985).

The handicapped, as a group, also tend to experience more dental caries than the general population, although these children benefit from fluoride as much as do non-handicapped children. A true picture of the dental health of the handicapped adolescent is unavailable. Unlike other minority groups, adolescents with handicaps, or for that matter, the handicapped in general, have not been adequately evaluated for dental

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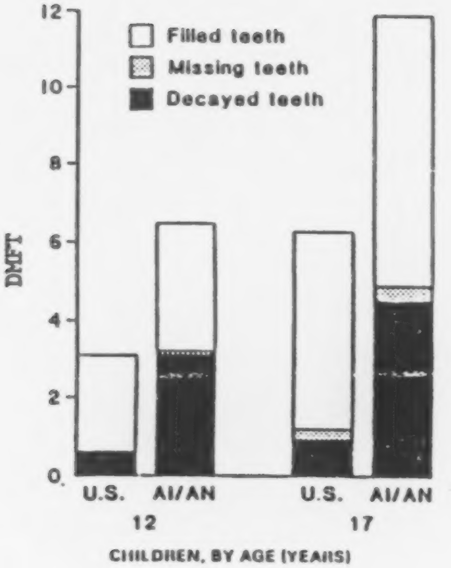

Figure 4. Comparison of Dental Caries (DMFT) for U. S. Population in General and Native Americans, Age 12 to 17 Years

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caries, except in small scale studies, which have used a variety of indices. One estimate (Nowak, 1984) actually showed a DMFT rate for 13-17-year-old handicapped patients of 6.0 as compared to 6.3 for that age cohort in the general population. The estimates used data drawn from more than 20,000 handicapped patients. The DMFT breakdown for 11-15-year-old handicapped teenagers was 1.18 (D), 2.48 (M), and 2.09 (F), suggesting that these patients are being treated, but continue to have dental caries which progresses to tooth loss. The lack of data, variety of indices, and inadequate variable control in multiple studies make conclusions about the state of dental caries difficult for the handicapped. Perhaps the only conclusion to be made is that further study is needed.

Other Forms of Dental Caries

Two other forms of dental caries affecting adolescents have been noted. The first is dental caries secondary to bulimia (Brady, 1980). The prevalence of this is not known, although the number of bulimics is believed to be in the thousands. The number of bulimics who actually experience enamel destruction and dental caries is also unknown. Too often, the teeth are affected, but without pain, so the patient does not seek

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care. Dental examination is not a common part of the patient evaluation for bulimia.

Once identified, the bulimic patient can be helped to control the breakdown of the dentition along with the treatment of the condition and its underlying causes. Unfortunately, restoration of this destruction is often expensive and may be put aside due to the high cost of other therapy.

The other recognized phenomenon is rampant caries. Though uncommon, rampant caries affects a small portion of teenagers, devastating the dentition and creating pain. While major studies of dental caries have shown a decrease in prevalence, others have also pointed out a changing pattern and distribution. A smaller percentage, perhaps as many as a fifth of children, get as much as half of the dental caries in the population (Graves, 1985). Studies of naval recruits (Hyman, 1983) shows similar findings--5 percent of those individuals account for 38 percent of new caries and 45 percent of replacement restorations.

Although the caries-active group is small, it represents a group which seems resistant to passive mechanisms which have benefited the population in general. More study is needed to address this group of adolescents and children.

Periodontal Disease

Adolescents are prone to a variety of acute and chronic periodontal problems ranging from mild puberty gingivitis to frank periodontal disease. Compared to dental caries, periodontal considerations are fewer and less severe, rarely leading to tooth loss during this age period.

National representative data from older studies paint a positive picture of periodontal health for most American teenagers. Over 66 percent of 12-17-year-olds had no periodontal disease in the surveys done by the Public Health Service in 1974. Most of those who did had gingivitis (32.2 percent) while only 0.7 percent had periodontal pockets greater or equal to 4 millimeters (U.S. DHHS, 1988).

Blacks tended to have a higher periodontal index (that is, worse periodontal health) than whites during teenage. The mean Periodontal Index for blacks and whites 6 to 11 years is about the same--0.11 for whites and 0.12 for blacks. During adolescence, the gap widens, so that by the adolescent period (12-17 years) the two groups score 0.29 and 0.53, respectively. It must be remembered that these scores do not represent significant

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disease, but they point to a continuing discrepancy through adulthood between races (U.S. DDHS, Health, 1985).

Oral hygiene plays a significant role in periodontal disease while it has less impact on dental caries. The Simplified Oral Hygiene Index (OHI-S) is a measure of oral cleanliness and plaque control. Whites, aged 12 to 17 years, tend to have slightly lower mean OHI-S scores than blacks (0.82 versus 1.34). Debris score, a component of the OHI-S, also favored white teenagers, whose scores (0.70) were slightly better than those of blacks (0.98) (U.S. DHHS, Health, 1985). Again, the scores are representative of relatively good oral hygiene but reflect differences in personal oral hygiene that may be indicators of access to care, patient education, or other factors ultimately related to dental disease.

The need for periodontal services provides an indirect indicator of disease. In the 1979-80 survey of children by the federal government (U.S. DHHS, 1981), using a scoring system that prioritized need from 0 (low need) to 4 (high need), the majority of 10-17-year-olds fell into category 1 (61.54 percent of 10-year-olds to 68.98 percent of 17-year-olds). Almost all of the rest

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(32.95 percent of 10-year-olds to 21.85 percent of 17-year-olds) fall into category 2. Blacks and others in the age range 10 to 17 years (Table 6) do not differ appreciably from whites, although their needs are somewhat greater.

Data from the Indian Health Service study show that by the end of adolescence, 2 out of 5 patients have destructive disease with bone loss (U.S. DHHS, Findings, 1985). Up until age 19, 6 out of 10 Indian children have incipient gum disease. Data for the handicapped show that periodontal conditions are significantly more a concern than caries (Tesini, 1981). Comparison of data of handicapped teenagers is difficult for reasons similar to those precluding dental caries associations between handicapped and non-handicapped.

A chronic condition peculiar to adolescence is localized juvenile periodontitis (LJP). It occurs in a small percentage of teens, usually early in adolescence (Zambon, 1986). Estimates are that LJP affects 0.1 to 2.3 percent of teenagers, with some predilection to certain minority groups (Saxer, 1981). This translates to thousands of teenagers with LJP. The condition can cause significant periodontal destruction if untreated, including bone and tooth loss. Since superficial

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Table 6.--Gingival Treatment Needs of Black and Others Compared to White 10-17-Year-Olds, 1979-80

PERCENT SCORE[*]

Age (Years)	White			Blacks/Others		
	0 or 1	2	3 or 4 Not Scored	0 or 1	2	3 or 4 Not Scored
10	63.14	33.99	2.87	69.47	27.35	3.17
11	61.24	35.33	3.43	69.93	25.24	4.83
12	61.28	34.64	4.08	71.71	24.40	3.89
13	63.84	31.73	4.44	68.84	26.03	5.13
14	67.76	27.54	4.69	68.68	23.80	7.52
15	69.78	26.22	4.00	65.57	25.62	8.81
16	75.59	23.93	3.48	64.45	29.93	5.63
17	75.35	21.24	3.42	67.93	25.43	6.64

[*] Scoring Criteria: 0 = free of disease; 1-2 = needs treatment; 3 = moderate problem; 4 = disease will not respond to self-care.

SOURCE: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, Dental Treatment Needs of the United States Children 1979-80, NIH Pub. No. 83-2246 (Washington, DC: U.S. Government Printing Office, December, 1982).

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gingival tissues can appear normal, the condition is often missed or diagnosed late in its course. A greater awareness of the condition by dentists and routine periodontal probing during the adolescent dental examination is needed to address this problem.

Smokeless tobacco use is a problem of adolescence and adulthood, with up to 60 percent of males 12 to 17 years of age having tried the habit, and about 1/3 of these using it 1 or more times per week (Greer, 1986). Other studies suggest that 8-10 percent of young males in many parts of the U.S. use smokeless tobacco regularly. The long-term effects of smokeless tobacco use on cancer incidence are not clear, but periodontal destruction is common (Figure 5) (Poulson, 1984; Offenbacher, 1985).

Malocclusion

Estimates of malocclusion in the adolescent population are also based on national data (DHEW, 1977). Malocclusion must be viewed as a condition which has both esthetic and health implications. In its minor and even moderate manifestations, it seldom creates pain and is rarely disfiguring. In its more severe form, malocclusion creates functional problems in chewing, predisposes one to periodontal conditions, and can create

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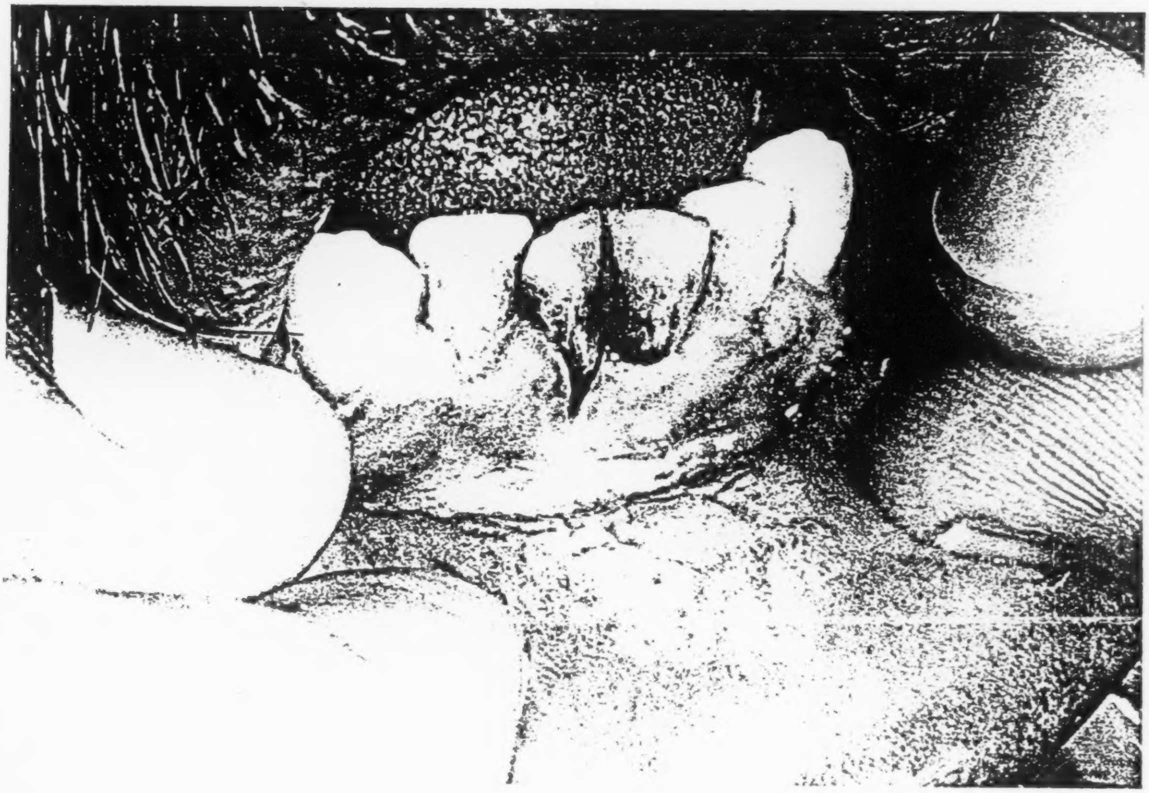

Figure 5. Constellation of Periodontal Destruction, Mucosal Change, and Staining of Teeth from Smokeless Tobacco Use

Source: Paul S. Casamassimo, 1989.

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significant problems of self-confidence and low self-esteem for afflicted individuals.

Malocclusion today is largely an inherited condition, but those groups at risk for premature primary tooth loss from dental caries still experience future orthodontic problems as a result. Similarly, many malocclusions of a minor variety can be intercepted and corrected or prevented by supervision of a dentist and provision of minor treatment. Access to care and utilization of care thus have implications for malocclusion. When one considers that the cost of orthodontic treatment is significant, these factors become more important.

Determining malocclusion prevalence is a complicated procedure including a variety of factors. Ultimately, it is an opinion. Survey data reflects the collective opinion of orthodontists who have examined patients and a variety of records, including radiographs and models of teeth. From these records, a score or Treatment Priority Index (TPI) is determined. Table 7 shows that the average TPI for youths age 12 to 17 years by sex and race. White males had the highest TPI of 5.2 in this 1970 survey, while black males had the lowest (4.6). These scores fall into a range in which there is

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Table 7.--Average Treatment Priority Index[1] for Malocclusion for Youths 12 to 17 Years of Age

Age (Years)	White		Black	
	Male	Female	Male	Female
12	5.2	5.6	4.1	4.9
13	5.2	5.0	4.2	5.6
14	5.1	4.7	4.8	6.1
15	5.5	4.8	5.0	4.9
16	4.9	4.6	5.3	5.0
17	5.4	4.8	4.5	3.9
For Group	5.2	4.9	4.6	5.1

[1] Treatment Priority Index is a score ranging from 0 (normal occlusion) to 10 (very severe handicap with treatment mandatory); 4-5 is considered a definite malocclusion but treatment elective.

SOURCE: U.S. Department of Health, Education and Welfare, Public Health Service, National Center for Health Statistics, An Assessment of the Occlusion of the Teeth of Youths 12 to 17 Years, DHEW Pub. No. (HRA) 77-1644 (Washington, DC: US Government Printing Office, February, 1977).

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a definite malocclusion, but treatment is elective. Table 8 shows a breakdown of the TPIs for all youths 12 to 17 years. About 16 percent of these teens had very severe malocclusion, while another 13 percent had severe malocclusion. It was estimated at that time that treatment was "mandatory" for 3.6 million youths.

McClain and Profitt (McClain, 1985) reviewed available data on malocclusion and found that malocclusion tended to worsen in adolescence. Crowding increases, Class II orthodontic problems worsen, and Class III problems become apparent in teenage. They also commented that no good United States studies comparable to those gone by USPHS (U.S. DHEW, 1977) were available. However, one must conclude that malocclusion must be at least as prevalent as it is in adolescence and may, in fact, worsen due to such factors as tooth loss and periodontal weakening.

Few data support the concept that malocclusion in general will result in major dental problems in adulthood (Isaacson, 1985). Obviously, there are severe malocclusions or localized problems which will cause irreversible damage. No clear relationship exists between periodontal disease, temporomandibular dysfunction, or other oral considerations.

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Table 8.--Percent Distribution of Treatment Priority Index (TPI) for All Ages for Youths 12 to 17 Years

	Total			White			Black		
TPI Score	Both	Male	Fem	Both	Male	Fem	Both	Male	Fem
0 (Normal Occlusion)	11.0	10.8	11.2	10.5	10.2	10.7	14.7	15.0	14.3
1-3 (Minor Malocclusion)	34.8	34.0	35.8	34.5	33.6	35.7	36.9	36.4	37.3
4-6 (Definite Malocclusion)	25.2	25.7	24.6	25.8	26.0	25.5	21.0	23.3	18.8
7-9 (Severe Malocclusion)	13.0	12.8	13.0	13.0	12.7	13.2	12.2	13.5	11.0
10 (Very Severe Malocclusion	16.0	16.7	15.4	16.7	17.5	14.9	15.2	11.8	18.6

SOURCE: U.S. Department of Health, Education and Welfare, Public Health Servic National Center for Health Statistics, *An Assessment of the Occlusion the Teeth of Youths 12 to 17 Years*, DHEW Pub. No. (HRA) 77-16 (Washington, DC: U.S. Government Printing Office, February, 1977).

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Interestingly, few good scientific data support the benefits of treatment. The role of orthodontic treatment for adolescents remains an area needing further investigation. Functional and psychological parameters need to be developed to assess treatment benefit, especially in the area of severe malocclusion and craniofacial deformity.

More recent data suggest that only a small percentage of children receive orthodontic care. Three quarters of 17-year-olds never receive orthodontic treatment; for blacks and other minorities the number increases to 96 percent at age 17, while for whites it is 73 percent. Female whites are most likely to have had orthodontic treatment by age 17. Black females do not differ appreciably from black males in likelihood of obtaining orthodontic care (DHHS, 1982). It appears that malocclusion occurs consistently across races, but treatment of orthodontic problems does not occur with similar equity.

Indirect Measures of Dental Disease in Children

The federal government keeps statistics on the effects of acute and chronic conditions, one group of which is dental. These are dental conditions of all types, and data are not broken down by actual dental

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problem. The measures used are acute conditions, those attended to by professionals, restricted activity days, and bed days and school days missed (U.S. DHHS, Current, 1988).

Acute dental conditions must require attention or have one of the above measurable effects to be listed. The number of acute dental conditions per 100 persons for 5-17-year-olds is 0.5 as compared to 1.3 for all ages combined. This translates to only 208,000 for the 5 to 17 year age group per year. These do not differ appreciably for blacks and whites (1.3 and 1.3 per 100 persons per year) at this age, and the occurrence actually increases with income levels of families, both of which may be explained by access to care rather than a true difference in occurrence.

Interestingly, occurrence in the 5 to 17 year period is lowest of 4 age periods (0.5 per 100 persons per year), and jumps by a factor of 3 in the 18 to 24 age period (1.8 per 100 persons). The prior period (under 5 years of age) also has a high incidence (3.6 per 100 persons per year). These changes may reflect a quiescent period, based on the true absence of problems, or represent a lack of attention to problems which in other periods of life are considered treatable. It may

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also reflect a period of neglect during which problems develop.

Two-thirds of these conditions are medically attended and little difference between races can be seen (71.3 for whites and 77.8 for blacks).

Restricted activity days or those short-term periods during which an individual's activity is below capacity for children 5 to 17 years of age are 1.5 per 100 persons per year. Black children under 18 years of age experienced slightly more than whites of the same age (6.9 per 100 persons versus 5.6 per 100 persons). Differences for various income levels did not show consistent trends, although families earning between 20,000-35,000 dollars per year tended to have the highest number of restricted days.

Bed days, in which a person spent more than half the day in bed, were also lowest for teenagers at 0.5 per 100 persons per year. For all children under 18 years, blacks seem to suffer more than whites with 4.3 bed days versus 1.4 bed days per 100 persons per year. Children from families with incomes ranging between 10,000 and 20,000 dollars show more bed days per year than other income groups, suggesting that those just above poverty may not get care.

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School days lost due to acute illnesses impacts blacks almost 4 times as much as whites for all children 5 to 17 years (3.9 days per 100 persons per year versus 1.0 per 100 persons per year). The highest occurrence, though, is not with lower income but middle income families with incomes between 20,000-35,000 dollars per year.

It is difficult to analyze these data since these measures reflect a variety of factors which are not apparent and these data are not broken down by adolescent periods. These indirect measures seem to ebb in frequency during adolescence and have no consistent relationship to income. For blacks, the effects of dental problems seem more significant, with more bed days and lost school. How much of this temporary disability is pertinent to adolescents is difficult to say.

If we assume that (1) approximately half of this group are considered teenagers, and (2) dental problems tend to increase in severity, then the number of adolescents who are represented in this statistic is sizable. In addition, because other indicators suggest that black children are more affected by activity limitations due to dental acute conditions, and because they and other minority children also tend to have more

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untreated caries, it is safe to assume that the effect of dental conditions or school attendance is greater for these children. Unfortunately, they can least affort it.

ADOLESCENT HEALTH KNOWLEDGE AND BEHAVIORS

The adolescent has not been studied widely for dental health attitudes, but what little information is available suggests that knowledge as well as behaviors are positive. A study of teenagers in Minneapolis found that almost three quarters of the predominantly white teens had a regular dentist. Ninety percent brushed daily and 80 percent felt tooth decay serious. Knowledge of dental health, however, was not as good, with only 84 percent believing that caries was preventable and few knowing about much about methods (Linn, 1976). More recent data suggest that attitudes to dental health are positive in adolescents, improve with education, and result in better behaviors (Walsh, 1985). A study of inner city, largely black teenagers (Brunswick, 1975) found them good predictors of their own oral health but less able to give an accurate assessment of their gingival health. There is some indication that self-image and appearance are important factors in oral health for adolescents (Linn, 1976, Lerner, 1976).

Data from national surveys (U.S. DHHS, Use, 1986)

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suggest that today's teens know more than previous generations. Younger adults (18 to 29 years) know as much or more than older adults about the benefits of fluoride, the positive effects of brushing and flossing on periodontal health, and the anti-caries benefit of sealants. Racial differences in this post-teenage period are small, suggesting exposure of all teens to preventive information. Sealant benefit is the one area about which minorities are less aware. Higher income and education levels of these young adults improved the likelihood of their knowing about these preventive benefits.

Whether knowledge and attitude translate to behavior is an unanswered question. The adolescent is unique in that for the first part of adolescence, he or she depends upon legal guardian for instigation of care visits, while at the end of adolescence, care seeking is a personal decision. Data on care seeking for the first part of this decade indicates that patterns of age groups have not changed over the last few years. Data from 1983 show children 5 to 17 years having 2.5 visits per year in 1983 and 2.4 in 1986. What is interesting and also consistent from these 2 study years is that the young adult (18 to 34) does not see the dentist as frequently (1.7 visits per year in 1983 and 1.8 in 1986). The rate

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of dental visits picks up in later adulthood. The most plausible explanation of these patterns is that (1) the young adult is no longer supervised or financed by a guardian, or (2) need for care or perceived need for care does not exist, or (3) a combination of these. Whatever the explanation, it appears that dental visits drop off in the transition between adolescence and young adulthood (U.S. DHHS, Use, 1986). Interestingly, the acute manifestations of dental conditions consistently increase in the early adult period (U.S. DHHS, Use, 1988).

Use of dental services has definite racial, income and education relationships relevant to adolescents. About two-thirds of 12 to 17 year olds saw a dentist for a 6-month or 12-month visit (66.6 percent). For white children, the percentage was slightly higher (69.5 percent). Only 51 percent of black children of this age had a 6- or 12-month visit. A similar smaller percentage of Hispanic teenagers (55 percent) had a visit within 12 months. Mexican American teens were even less likely to have such a visit (48.4%). The likelihood of regular visits increases with family income and private dental insurance coverage. About 4 out of 5 12-17-year-olds with private dental insurance have at least annual visits to the dentist (78.4 percent) as compared to about 3 of

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5 without it (U.S. DHHS, Use, 1988).

The teenage handicapped--as indicated by those who are unable to conduct a major activity--tend to have visits even less often than other underserved groups, with only 54.4 percent of 12-17-year-olds having had at least an annual visit. Those teens with less disability or limitation do only slightly better (62.2 percent). This may relate to a variety of factors, including preoccupation with one's handicapping condition (Entwistle, 1981), inability to find a dentist (Siegal, 1985), or a combination of these and other factors, including financing (Gotowka, 1982).

Those adolescents 12 to 17 years of age with no dental visits within the last year includes 25.9 percent of whites, 44.3 percent of blacks, 40.6 percent of Hispanics and 42.9 percent of Mexican Americans. Likelihood of a visit within the last year increases with family income and private dental insurance. Only half the handicapped adolescents, unable to carry on a major activity, had a dental visit within the last year (U.S. DHHS, Use, 1988).

Since the likelihood of care for adolescents increases with availability of private dental insurance, it is apparent that blacks and Hispanics and the poor and

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the handicapped are at a disadvantage. Table 9 shows a comparison of the dentally insured general population of 12-17-year-olds with those from other groups.

Preventive health practices of teenagers are very positive, based on national data. Well over 90 percent of all children 9 to 16 years of age use a fluoridated toothpaste. If fluoride supplementation can be assumed to be an indication of inadequate communal water fluoridation, then a majority of these teens receive adequate systemic fluoride in drinking water. Income and race do not seem to affect these parameters (U.S. DHHS, Use, 1988).

SUMMARY OF DENTAL DISEASE AND RISK FACTORS FOR ADOLESCENTS

Available data suggest that dental disease and its treatment in the adolescent population occur in certain patterns. Certain ethnic, racial, and socioeconomic groups tend to be affected more frequently or severely by certain conditions and tend to have differing patterns of care.

. Dental caries increases through adolescence. Blacks tend to have less caries but tend to experience its sequelae more severely than whites, most likely due to lack of professional care. The discrepancy between

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Table 9.--Characteristics of the 12-17-Year-Old Population Who Do and Do Not Have Dental Insurance, By Percentage[*]

Characteristics	Have Private Dental Ins.	Do Not Have Private Dental Ins.
Males	44.0	52.1
Females	42.2	53.3
Whites	45.6	50.3
Blacks	30.2	65.2
Hispanic	35.1	60.5
Mexican-American	36.8	59.6
Other Hispanic	33.0	61.7
Central City (MSA)	37.8	56.9
Not Central City (MSA)	50.9	45.6
Northeast	45.9	50.7
Midwest	49.8	45.1
South	34.3	61.2
West	48.0	48.7
Under $10,000 Family Income	10.6	86.5
$10,000-$19,000	28.3	67.9
$20,000-$34,999	50.5	46.6
$35,000 or More	63.1	33.8
Unable to Complete Major Activity	26.0	74.0

[*] Totals do not equal 100 due to unknown coverage.

SOURCE: U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, Use of Dental Services and Dental Health , United States, 1986, DHHS Pub. No. (PHS) 88-1593 (Washington, DC: U.S. Government Printing Office, October, 1988).

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a lower prevalence but greater severity (untreated disease, more extensive treatment needs) suggests that minorities have benefited from passive preventive measures, most notably fluoride, but have not benefited from professional preventive or therapeutic measures.

- Some groups, most notably the native Americans, do not seem to reap the same benefits of caries prevention or treatment.
- The handicapped adolescent has not been adequately studied but appears to benefit from passive measures, but is not seen professionally as often as others.
- Periodontal considerations in the general adolescent population are minor; however, indications of incipient disease or lack of care or knowledge suggest that minority groups may be at greater risk of long-term sequelae of periodontal problems, even while in teenage. Because of a variety of factors, these groups never recover to the same level of health as other groups or do so late in life.

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- Malocclusion remains a largely untreated condition, even in its severest forms. Treatment of malocclusion remains the benefit of those with higher incomes.
- Minorities tend to experience the significant sequelae of dental conditions more than whites. While the adolescent, in general, tends to experience the fewest effects on activity, the late adolescent and young adult experiences the most, after the under-5 child. The impact of acute dental conditions as compared to other acute conditions on school performance or work is not known.
- Minority status, low income, lack of dental insurance, and handicaps tend to predispose teens to a lack of care by dentists, as compared to the general population and whites.

It is important to note that available data do not adequately portray special groups with enough detail to make conclusions at a finer level, nor to provide causal explanations. Another problem with current data are long-term projections and assignment of long-term effects to current status. However, some predictions can be made

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based on available data:

- The caries rate has decreased consistently over the last 2 decades and most likely will continue to do so. However, the benefits of passive preventive fluoride appear to be peaking (U.S. DHHS, DHHS News, 1988). So, sealant intervention, which is currently low (fewer than 10 percent of teens have sealants) will need to be increased, and this means office visits or school-based or community-based sealant programs.
- Far more children are seeing dentists prior to age 5 years. In 1982, over 50 percent of 5-8-year-olds had seen a dentist before age 5 years, while only 34.5 percent of 15-16-year-olds had had their first visit prior to age 5 years (U.S. DHHS, Use, 1986).
- Groups who tend to suffer from extremes in dental disease tend not to recover from the effects, although in many instances, differences between them and the general population wane in later life. Although causal relationships are difficult to establish for such conditions as gingivitis

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and long-term tooth loss, it is safe to say that teens who lose teeth in the adolescent period will add to those adults counted as partially edentulous.

PROGRAMS AND SERVICES THAT ENHANCE ADOLESCENT DENTAL HEALTH

Few data are available which directly support the benefits of certain interventions on adolescent dental health. Few, if any, trace adolescents into adulthood. Results of the National Dental Caries Prevention Program indicate that a combined program of education, fluoride, and sealants had a greater benefit than did lesser programs in both fluoridated and non-fluoridated communities. More significant, perhaps, is the recognition that sealants represent the most significant preventive measure after fluoride in reducing dental caries (Bohannon, 1985).

Fluoride remains the major element in the overall improvement in oral health in today's adolescents. Water fluoridation and topical rinse programs have been demonstrated effective in hundreds of studies too numerous to mention (Bohannon, Fluoride, 1985). Today, slightly over half of the U.S. population has access to fluoridated drinking water (Winkeljohn, 1986). Approximately 10 percent of school children have access

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to school fluoride rinse programs (U.S. DHHS, Use, 1988).

The role of dental visits in adolescent health is unclear. Access to care may be the real issue rather than periodic intervention, the difference being treatment versus provision of primary prevention by a dental health professional. The data from national surveys indicate adolescence as a time during which identifiable disease increases, but acute problems tend to decrease in occurrence, only to reappear in adulthood.

The American Academy of Pediatric Dentistry recommends periodic visits for adolescents based on needs (Appendix). In addition to evaluation for dental caries, periodontal probing is advised as a consistent part of the adolescent dental examination.

The benefits of education are hard to assess. Studies show a short-term benefit of educational intervention, but lasting effects are uncommon, and while education tends to increase knowledge (Walsh, 1985), its lasting effect on attitudes and then behaviors is less significant (Flanders, 1987).

In summary, it appears that the techniques and programs most likely to benefit adolescent oral health are:

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1. access to fluoridated communal or local drinking water or appropriate supplementation
2. dental sealants on occlusal surfaces of teeth
3. supplemental topical fluorides
4. access to periodic professional care for identification of incipient dental disease, and provision of treatment of existing treatable minor dental disease

FEDERAL PROGRAMS RELATED TO HEALTH PROMOTION AND DENTAL HEALTH

A variety of federal programs have had a major impact on the dental health of adolescents. The most significant of these has to be water fluoridation. The federal initiative is decades old. Today, it is estimated that 56.5 percent of the population served by public water supplies has access to optimal fluoride, while 52.5 percent people receive water fluoridated to 0.7 parts per million through community water (Corbin, 1988). Federal services have been through grants to states, largely, as well as through technical assistance, health education, and other methods. The Dental Disease Prevention Activity (DDPA) of the Centers for Disease Control (CDC) has been responsible for this effort over the last decade (Corbin, 1985). The future of

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fluoridation depends on both local and national variables, not the least of which are the nature of grant monies (consolidated block or categorical), federal regulations on maximal naturally-occuring fluorides, and local acceptance. The block grant structure has allowed states flexibility in applications of funds, some of which appear to go for fluoride programs.

Fluoride mouthrinsing in schools is another beneficial, yet seemingly uncommon technique. In 1983, only 2.3 percent of children 5 to 17 were exposed to fluoride rinsing (Winklejohn, 1986). The number has increased slightly to about 10 percent.

Dental sealants are another area in which the federal government has taken an initiative, both in support of delivery of sealants and public education. Maternal and Child Health has, for example, funded sealant programs through its SPRANS Program (Beck, 1985). State agencies are utilizing federal funds to initiate sealant programs in various parts of the country (Siegal, 1989). Again, local factors such as practitioner attitudes, low public awareness, and low priority for dental health, have limited the availability of sealants. Activities such as the Consensus Conference, sponsored by the National Institutes of Health in 1984, attempt to

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affect some of these factors (U.S. DHHS, 1984). The NIH and CDC/DDPA efforts continue in this regard with grants to states and public awareness programs.

The poor and minority population appear to be at risk for dental disease due to a variety of factors, including access to care. The Public Health Service provides support for these populations through community health centers and migrant health programs (Schneider, 1985). Recent budgetary changes over the last decade--both in terms of amount and format of allocations--has affected the complexion of services, including adolescent dental health services. Existing data suggest that programs are not adequate to meet the dental health care needs of adolescents who are unable to gain access to the private health care system. Medicaid, a primary means of gaining access to the private sector for the underserved low income adolescent, is often an ineffective program due to its pattern of allowable services, low reimbursement, and burdensome paperwork. The American Dental Association reported, for example, in 1988, that only 21 states and the District of Columbia covered dental sealants, a service which holds the greatest promise for caries reduction in the next decade. At least 1 state discontinued sealants from its program.

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Forty-two states and the District of Columbia reported that of over 16 million eligible Medicaid recipients, only about one-third had a dental service of some kind performed (ADA, 1988).

Data Collection Programs and Research

Several authors involved in dental epidemiology and research, as well as dental public health, have noted that federal data collection programs may not provide accurate projections of need within special populations (Corbin, 1985; Graves, 1985; U.S. DHHS, Findings, 1985). While data collection provides overall trends, it tends to mask the real disease status of certain populations. The general nature of statistics compiled by the federal government may lead to complacency about dental diseases which still affect certain population groups of adolescents significantly. Some effort should be made to address disease-active teenagers, as has been done by the National Institutes of Health on smokeless tobacco use (U.S. DHHS, The Health, 1986).

Basic and applied research sponsored by the National Institute of Dental Research has directly and indirectly benefited the adolescent patient. Such areas as dental caries, periodontal disease, craniofacial abnormalities, behavior and sedation, and trauma, have

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all been studied with application of research findings to the adolescent population as appropriate. The knowledge gained from sealant research, for example, has direct bearing on the health of today's adolescent (U.S. DHHS, Annual, 1986).

POLICY ISSUES

Undeniably, dental health of adolescents is improving. The rate of improvement and the likelihood of all groups within this segment of the population benefiting from this trend will depend upon continued efforts in several areas. Some general recommendations which emerge from the review of adolescent dental health issues are:

1. Federal programs which support fluoridation of community water need to be continued and aimed at the roughly half of the population which does not have access to optimally fluoridated water.
2. Sealant use needs to increase, and federal programs which advocate sealant placement must be emphasized if we are to see a further major decrease in dental caries in adolescents.
3. For a variety of reasons, minority groups and the handicapped remain underserved. One

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assumption is that programs aimed at these groups are inadequate. Another is that these populations do not benefit equivalently from available preventive and treatment methods which appear to benefit the general adolescent population.

4. The patterns of disease, care utilization, and effects of dental disease in adolescents merit further in-depth study. Casual and organized observations suggest that the adolescent may be considered dentally sound due to improved early intervention but, in fact, is developing problems which will emerge in adulthood. Some effort should be given to studying the adolescent patient, especially from mid- to late adolescence.

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GUIDELINES FOR DENTAL HEALTH OF THE ADOLESCENT

May, 1986

Adolescents currently comprise 20% of the United States population. This percentage will remain the same or decrease slightly in the year 2000. Historically, the adolescent has been perceived largely as a dental patient who experienced an increase in caries due to a greater intake of refined carbohydrates superimposed on unusually careless oral hygiene habits. Orthodontic management of malocclusion, if present, constituted the image of the delivery of special care for most adolescents.

Until recently, the dental curriculum has been a "no man's land" for adolescents, with their special needs either being ignored or spread haphazardly between pediatric dental, restorative, and community dentistry departments.

Although the age range of child dental care has been defined by the American Academy of Pediatric Dentistry as from birth to 21 years of age, until recently, few pediatric dentists included many adolescents in their practices. However, as caries rates in children have declined and increasing numbers of parents prefer to have their children followed by the pediatric dentist, it has become quite apparent that the skills of the pediatric dentist (primary preventive care) are not only essential, in many cases they are indispensable (space maintenance, minor orthodontics, care of traumatic injuries).

It is the Academy's position that because of the unique nature of adolescent dental problems, the long-term health of the permanent dentition is more likely to be assured if the dental needs of the adolescent are under the care of the pediatric dentist.

Recognition of the adolescent today as a patient with special needs is due, in part, to the following factors: (1) a caries rate that continues to accelerate during adolescence; (2) modern knowledge about the pivotal nature of adolescence in periodontal disease; (3) the greater awareness of the extent of both treatment and preventive needs for hard and soft tissues within this group; (4) the complexity of care for the adolescent with combined orthodontic and restorative care; e.g., congenitally missing teeth; and (5) dental phobia.

These guidelines address disease entities within the adolescent population and propose general guidelines for their management.

Dental Caries

Dental caries continues to be the major dental infectious disease problem for the adolescent. Current research suggests that the caries rate is declining; yet the rate remains highest during adolescence. Of concern to the health professional is the changing pattern of dental caries within the population. The numbers of caries-free children are increasing. Furthermore, there is growing evidence that a small percentage of children account for most severe decay. Within the middle group there is a number of children whose decay is often confined to developmental pits and fissures. These changes in disease rates and distribution are being attributed to the positive effects of fluoridation, professional care, patient education, and personal hygiene.

Adolescents are still prone to tooth decay. Immature permanent teeth and a total increase in susceptible surfaces contribute to this. Environmental factors such as diet, independence to seek care or avoid it, and a low priority for oral hygiene may contribute to the lingering upward slope of caries rates in adolescence.

1. Management of Caries

A. Primary Prevention

Fluoride: Fluoridation has proven the most economical and effective caries preventive measure. The adolescent can benefit from fluoride throughout the teenage years and into early adulthood. Although the systematic benefit of fluoride incorporation into developing enamel is not considered necessary past 13 years of age, the topical benefits of remineralization and antimicrobial activity still can be obtained through water fluoridation, professionally applied and prescribed compounds, and fluoride dentifrices.

Recommendations: The adolescent should receive maximum fluoride benefit.

1. Systemic fluoride intake via optimal fluoridation of drinking water or professionally prescribed supplements is recommended to 13 years of age or the eruption of the second permanent molars, whichever comes first.
2. A fluoride dentifrice is recommended to provide continuing topical benefits through adolescence.
3. Regular professionally applied fluoride treatments should be deemed professionally necessary through adolescence as during the early childhood period and based on the individual patient's caries pattern and fluoride status of community water.

4. **Topical fluoride supplementation via home-applied compounds should be a professional recommendation when indicated by an individual's dental caries pattern or caries risk status.**

The criteria for determination of need and the methods of delivery should be those recommended by the American Dental Association.

Oral Hygiene: Toothbrushing with fluoride-containing dentifrice and flossing can provide anticaries benefit through plaque removal from tooth surfaces and the topical effect of the fluoride.

Recommendation: Adolescents should be educated and motivated to maintain personal oral hygiene through daily plaque removal. Frequency and pattern of tooth cleaning should be based on the individual's disease pattern and oral hygiene needs. Flossing should be a part of an oral hygiene program. Professional removal of plaque and calculus is a highly recommended procedure for the adolescent. Several recent studies have demonstrated that 30-50% of adolescents aged 13-15 have calculus. The frequency of such intervention should be determined by a dentist.

Diet Management: The role of carbohydrates in caries initiation is unequivocal. The adolescent can benefit from diet analysis and modification when caries is a problem.

Recommendation: Diet analysis, along with professionally determined recommendations for maximal general and dental health, may be a part of an adolescent's dental health management. A diet analysis and management should consider: (1) dental disease patterns; (2) overall nutrient and energy needs; (3) psychosocial aspects of adolescent nutrition; (4) dietary carbohydrate intake; and (5) wellness considerations.

Sealants: Pit and fissure sealants can be of significant benefit to those whose dental caries affects mainly pits and fissures. The occlusal surfaces of second molars in adolescents are highly prone to caries attack. Sealants are an effective decay-preventive technique that should be used on an individual basis.

Recommendation: Adolescents should have pit and fissure sealants available as a caries preventive technique. Sealants should be professionally deemed necessary and according to current standards, applied using criteria such as the caries history, age of patient, length of time a tooth has been exposed to the oral cavity, and tooth surface anatomy.

B. Secondary Prevention

Professional intervention for dental caries may find existing disease in its early stages. The adolescent patient who has not been seen by a dentist for a year or more may have advanced caries or periodontal disease urgently in need of professional evaluation and extensive treatment.

Recommendations:

1. The adolescent dental patient should be professionally evaluated by a dentist who is thoroughly trained in the special needs of the adolescent.
2. Periodic recall examination should be at a frequency which provides the most cost-effective disease-preventive benefit to the adolescent.
3. Initial and periodic radiographic examination should be a part of a clinical evaluation. The type, number, and frequency of films should be professionally determined only after oral examination and history taking. Previously exposed radiographs should be available for comparison. Special attention should be given to the physiological status of the adolescent, and the potential of gonadal or fetal x-ray exposure in pregnant patients.

Periodontal Diseases

Adolescence appears to be a critical period in periodontal status of the human. Epidemiologic and immunologic data suggest that irreversible tissue damage from periodontal disease begins in late adolescence and early adulthood. Pubertal changes characteristically affect the periodontium of the young adolescent with an increase in inflammation which is, in most cases, manageable through oral hygiene and regular professional care. The adolescent is also prone to a number of acute periodontal conditions which require immediate and occasional long-term management.

Acute Conditions: The adolescent periodontium may be subjected to acute conditions such as acute necrotizing ulcerative gingivitis, periodontitis, and traumatic injuries. In most cases early treatment and appropriate management can prevent irreversible damage.

Recommendation; Acute intraoral infection involving the periodontium and oral mucosa require immediate treatment. Therapeutic management should be based on current accepted techniques of periodontal therapy. Traumatic injuries to the teeth and periodontium require referral to a dentist for evaluation and treatment.

Chronic Conditions: The chronic conditions affecting the adolescent include, but are not limited to gingivitis,

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puberty gingivitis, hyperplastic gingivitis related to orthodontic therapy, drug-related gingivitis, pregnancy gingivitis, localized juvenile periodontitis, and periodontitis. Personal oral hygiene and regular professional intervention can minimize occurrence of these conditions and prevent irreversible damage.

Recommendations: The adolescent will benefit from an individualized preventive dental health program which includes the following items aimed specifically at periodontal health:

1. Patient education emphasizing the etiology, characteristics, and prevention of periodontal diseases, as well as self-hygiene skills.
2. Personal age-appropriate oral hygiene program including plaque removal, oral health self-assessment, and diet. Sulcular brushing and flossing should be included in plaque removal. Initially the adolescent should be frequently apprised of methods to determine adequacy of plaque removal and improvement of gingival health. Diet considerations to insure optimal oral and general health should be included.
3. Regular professional intervention, the frequency of which should be based on individual needs and which should include evaluation of personal oral hygiene success, periodontal status, and potential complicating factors such as medical conditions, malocclusion, or handicapping conditions. Attention to periodontal needs should be given at all ages, but the use of periodontal probing, periodontal charting, and radiographic periodontal diagnosis should become a consideration when caring for the adolescent. The extent and nature of the periodontal evaluation should be professionally determined on an individual basis.

Occlusal Problems

Malocclusion remains a significant treatment need in the adolescent population. Both environmental and genetic etiologic factors come into play. Although the genetic basis of much malocclusion makes it unpreventable, numerous treatment methods exist to treat the occlusal disharmonies, temporomandibular joint dysfunction, periodontal disease, and disfiguration which may be caused by malocclusion. Within the area of occlusal problems are several tooth-jaw related disorders which can affect the adolescent. Third molar malposition and temporomandibular disorders are not infrequent in adolescents and require special attention to avoid long-term problems. Congenitally missing teeth present complex problems for the adolescent and often require combined orthodontic and restorative care for satisfactory resolution.

Malocclusion: Any tooth-jaw positional problems which present significant esthetic, functional, physiologic, or emotional dysfunction are potential difficulties for the adolescent. These can include single or multiple tooth malpositions, tooth-jaw size discrepancies, and craniofacial disfigurements. Treatment of malocclusion and related problems should be by an appropriately trained dentist.

Recommendation: Any malposition of teeth, malrelationship of teeth to jaws, tooth-jaw size discrepancy, bimaxillary malrelationship, or craniofacial malformations or disfigurement which presents functional, esthetic, emotional, or physiologic problems to the adolescent should be evaluated by the appropriately trained dentist or professional team. Treatment of malocclusion should be based on professional diagnosis, available treatment options, patient motivation and readiness, and other factors to maximize prognosis.

Third Molars: Third molars can present acute and chronic problems for the adolescent. Impaction or malposition leading to such problems as pericoronitis, caries, cysts, or periodontal problems merits evaluation for removal. The role of the third molar as a functional tooth is also to be considered.

Recommendation: Evaluation of third molars should be an integral part of the dental examination of the adolescent. This evaluation should include radiographic diagnostic aids. Third molars which are determined to be potential or active problems should be considered for treatment by the appropriately trained dentist. Diagnostic criteria for extraction should be those currently accepted by the dental profession.

Temporomandibular Joint Problems: Disorders of the temporomandibular joint can occur at any age, but adolescence may provide the stimulus to trigger problems due to increased stress and orthodontically induced disharmonies.

Recommendation: Evaluation of the temporomandibular joint and related structures should be a part of the examination of the teenager. Abnormalities should be managed by an appropriately trained dentist.

Congenitally Missing Teeth: The impact of a congenitally missing permanent tooth on the developing dentition can be significant. Attention should be given to both immediate and long-term management of such problems no later than adolescence.

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Recommendation: Evaluation of congenitally missing permanent teeth should be done no later than adolescence. Treatment planning should include both immediate and long-term management.

Special Considerations in Management of Oral Problems in Adolescence

The adolescent can present particular psychosocial characteristics which impact on the health status of the oral cavity, as well as care seeking and compliance. The self-concept development process, emergency of independence, and the effects of peers are just a few of the psychodynamic factors impacting on dental health during this period.

Behavior management of the adolescent may require dealing with anxiety, phobia, or intellectual dysfunction. These special needs patients should receive attention to these aspects of their care by appropriately trained dentists. Referral to nondental professionals or a team approach may be indicated.

Specific examples of oral problems associated with adolescent behaviors include, but are not limited to: (1) oral manifestations of venereal diseases; (2) effects of tobacco (leukoplakia, tissue damage from smokeless tobacco); (3) effects of oral contraceptives on periodontal structures; (4) perimyolysis in anorexia nervosa; (5) traumatic injury to teeth and oral structures in athletic or other activities (short- and long-term management).

The impact of psychosocial factors relating to oral health must include consideration of the following: (1) changes in dietary habits (fads, freedom to snack, increased energy needs, access to carbohydrates); (2) use and abuse of drugs; (3) motivation for maintenance of good oral hygiene; (4) potential for traumatic injury; (5) adolescent as responsible for care (age of majority); (6) lack of knowledge about periodontal disease. Physiologic changes also can account for significant oral problems in the adolescent, manifesting at first in this age group. These include: (1) loss of remaining primary teeth; (2) eruption of remaining permanent teeth; (3) gingival maturity; (4) facial growth; (5) hormonal changes.
Recommendations:

1. The adolescent's dental health care should be provided by a dentist who has appropriate training in awareness and management of the specific needs of this patient. The general dentist should consider referral to a specialist for treatment of particular problems outside his or her expertise. This may include both dental and nondental problems.

2. Attention should be given to the particular psychosocial aspects of adolescent dental care. Issues of consent, confidentiality, compliance, and others should be addressed in the care of these patients.
3. A complete oral health care program for the adolescent requires an educational component which addresses the particular problems of the adolescent patient and focuses on: specific behaviorally and physiologically induced oral manifestations in this age group; shared responsibility for care and health by the adolescent and provider; and consequences of adolescent behaviors on oral health.

American Academy of Pediatric Dentistry,
211 E Chicago Avenue, Chicago, IL 60611

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LEGENDS

Figure 2.-- Appearance of adolescent puberty gingivitis in a young teenager. The condition, while prevalent, is self-limiting and rarely a problem.

Figure 5.-- This is the classic constellation of periodontal clefting, staining of teeth, and mucosal alteration from chronic use of smokeless tobacco.

U.S. Congress
Office of Technology Assessment

Draft
Unintentional Injury Among Adolescents

Background Paper for Adolescent Health Project
Prepared under contract to
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by

Carol W. Runyan, MPH, PhD
Elizabeth A. Gerken, MSPH
Laura S. Sadowski, MD, MPH

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Comments should be sent to:
Andrea Solarz, PhD
Adolescent Health Project
Health Program
Office of Technology Assessment
U.S. Congress
Washington, D.C. 20510-8025
Phone: 202/228-6590
FAX: 202/228-6098

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UNINTENTIONAL INJURY

EXECUTIVE SUMMARY

Unintentional injuries are responsible for more deaths to adolescents than any other problem, accounting for the loss of almost 11,000 deaths annually. This represents 74 % of all deaths to persons between ages 10 and 19.

These injuries result in more loss of potential life in the United States than any other health problem. Injury deaths are associated, on average, with 36 years of life lost as compared to 16 years for cancer and 12 years for cardiovascular disease. However, funding for research has been computed to be $31 per year of life lost for injuries as compared to $195 for cancer and $86 for cardiovascular disease.

Deaths are just the tip of the iceberg. For every injury death to an adolescent, more than 41 are hospitalized and as many as 1100 require emergency room care.

The deaths and long term disabilities together account for annual costs of more than $39 billion for the age group between 15 and 24.

The major causes of unintentional injury death among adolescents are associated with motor vehicle crashes and drowning, though sports and recreation-related injury contribute substantially to the toll in nonfatal occurrences. Occupationally-related injuries, although less well documented, also appear to be a potentially serious concern.

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Effective prevention of injuries, both intentional and unintentional, requires attention to the multiple, interacting factors that contribute to the problem. These include elements of the social and physical environments, product design and marketing, and adolescent development and behavioral patterns. Generally, the most successful interventions do not require the active involvement of the at-risk individual, but rather make structural changes that protect people without their having to take repeated actions on behalf of their own safety.

To accomplish these types of efforts often requires legislative change, as well as massive education of the public and policy makers. Other regulatory approaches and/or individualized education are important adjuncts to policy development. Sometimes litigation, or the threat of litigation, is required to provide the necessary leverage for change.

Policy initiatives are sometimes more controversial because they may limit the freedom of individuals for the good of the community. However, the effectiveness of passive and mandatory measures is usually greater than that of measures that rely solely on educational approaches to change behavior.

The emergency medical system has been developed to provide the initial treatment of traumatic injuries among adults. Littel attention has been given to the specific treatment needs of adolescents. Adolescents have higher rates of hospitalization for motor vehicle crashes, poisoning and head trauma than do adults, yet protocols that attend to the unique developmental

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characteristics of adolescents as well as to the nature of their injury problems need to be developed and differentiated from those protocols pertinent strictly to adults or young children.

The development of cost-effective preventive and treatment protocols and policies requires improvements in the available data. Funds and directives must be provided for improvements in the on-going monitoring of injury trends to evaluate both preventive and treatment efforts. In addition, epidemiologic and behavioral research to document the factors associated with injuries and evaluation studies to examine the effectiveness of interventions is a critical unmet need, requiring funds far in excess of what has been provided to date.

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INTRODUCTION

Unintentional injuries are among the leading health problems facing adolescents. In the United States, 10,785 deaths and thousands more lifelong disabilities from unintentional injuries occur each year among those ages 10-19 (National Center for Health Statistics, 1984,1985,1986). Since injuries disproportionately affect youth, more years of potential life are lost from injuries than from cancer and heart disease combined.

Attention to adolescent injury is relatively recent. Before the turn of this century, adolescence was not even defined as a life stage. Injuries have gained recognition as a significant health concern over the last two decades. The explanation for the failure to address this critical issue sooner may lie in our concepts of injuries as "accidents" as well as in the unique qualities of adolescence as a life stage.

Many of the factors contributing to the excess risk for injuries are associated with the developmental characteristics of adolescents. These include discrepancies among the physical, cognitive, emotional, and social development of youth and the relationship between adolescents' developmental status and their physical and social environment. For example, the hazards associated with mastering a complex task such as driving are magnified by the adolescent's challenge of adult authority (e.g., failing to adhere to speed limits), desire for autonomy (e.g., freedom from relying on parental transportation), experimentation with risky situations (e.g., driving while intoxicated), and efforts to seek peer approval (e.g., experimenting with drugs and alcohol) while enhancing self-esteem (e.g., showing off the power of one's car).

While the characteristics of adolescent development contribute to the injury problem in important ways, their contributions can only be understood in the socio-cultural milieu in which they operate. This includes the availability of alcohol and high powered vehicles, media portrayals of fast driving, drinking, and the non-use of seatbelts, and the scarcity of entertainment alternatives that do not require personal transportation. The complex interactions of socio-cultural factors with the adolescent's developmental stage requires broad-based multifaceted prevention efforts.

This report reviews the epidemiology of unintentional adolescent injury in terms of its etiology, consequences, known risk factors and preventive strategies. In addition, the report will address concerns relative to immediate and short term treatment or adolescent injuires and will examine opportunities for research and policy development.

Definitions and Conceptual Frameworks:

The past failure to adequately address injuries as a health concern is, in part, a function of the ambiguities that envelope our understanding of injury causation and injury prevention. Most early efforts focused on "accident" prevention. More recently, attention has been directed toward injury prevention, which includes not only the prevention of the events ("accidents") that lead to injuries, but also the injuries themselves.

The term **"accident"** carries connotations that probably have hindered preventive efforts. According to Webster's dictionary, an accident is an "...unforeseen and unplanned event or circumstance...an unexpected happening..." (Websters Dictionary, 198_). This definition implies that injuries are the result of unforeseen, unpredictable, and uncontrollable events. It supports the notion that accidents "just happen" and thereby may limit the scope of injury prevention by suggesting that injury producing events are inevitable, must be tolerated, and that injury prevention is futile.

In contrast, injury is defined as sudden damage to the body resulting from exposure to a transfer of energy from thermal, chemical, mechanical, electrical, or radioactive sources, or from the sudden absence of an essential agent; for example, lack of oxygen in drowning or heat in the case of frostbite. Energy is the agent of injury in the same way that viruses or bacteria are the agents of infectious diseases. Both the disease and injury processes result from the dynamic interactions among the human host, the agent, and both the physical and social environments.

The implication of this conceptualization is that injuries can be prevented by directing efforts at the host (e.g., the adolescent's behavior), agent (e.g., modifying the speed of the car or motorcycle), or the environment (e.g., the design of highways or availability of alcohol and driver's licenses).

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Interventions can be directed at preventing the initial event (e.g. a motor vehicle crash) that might lead to injury and/or reduce the probability or severity of injuries if the event does occur.

While this report deals only with unintentional injury, it is important to recognize the commonalities with intentional injury. Intentional (homicide, suicide, other forms of assault) and unintentional ("accidental") injuries should be considered together within this conceptual framework, regardlesss of the obvious differences in motive. A handgun in the bedside table functions as the injury agent in the accidental shooting of a child, in a homicide resulting from a domestic argument, and in a teenage suicide; all of which can occur in the home environment. This suggests many very similar approaches to intervention.

EPIDEMIOLOGY OF ADOLESCENT INJURY

General Principles and Data Sources:

Information about mortality is derived primarily from death certificate data, collected by each state and compiled at a national level by the National Center for Health Statistics. Included on the death certificate is information about demographics (age, sex, race, residence), as well as the "primary and contributing causes" of death. For injury deaths, causes are based on the International Classification of Diseases (ICD) external cause of injury code, referred to as **E codes**. E codes are derived from the description of the injury-producing event. In many states, excellent data on injuries are also available from the medical examiner or coroner system where more extensive descriptions of the injury event often can be obtained. In some states this information is computerized, but in most states, the use of medical examiner data requires manual record review.

Morbidity information is much less available and generally of poorer quality. The major sources of morbidity data include hospital discharge records, emergency room records, the records of emergency service personnel, private health care providers, or special studies (e.g. the National Health Interview Survey). There is no comprehensive and consistent nationwide system of hospital record-keeping, although a number of states have routine discharge data collection systems and there is a National Hospital Discharge Survey that records information from a sample of hospitals nationwide. However, the inclusion of E code information varies considerably within this system. Because hospitals rely on diagnostic information for cost reimbursement, morbidity information is routinely coded according to diagnosis. In the ICD schema, these codes are **N codes**, referring to the "Nature of Illness or Injury." The N code allows distinctions, for example, between a fractured femur, a lacerated liver, and a concussion. As mentioned above, another code (E code) is used to depict the "external cause of the injury;" for example, differentiating a fall down a flight of steps from a motor vehicle crash. Information about the circumstances of an injury that would permit coding of the appropriate external cause is not routinely included in sufficient detail in medical records to permit use of the data for large scale analysis of injury problems.

Types of injury data:

Ideally, epidemiologic measures take into account the element of exposure; for example, the hours of football played or mileage driven. This requires information that is often not available. Hence, the comparisons among frequencies and rates must be made with caution, considering the potentially different levels of exposure associated with a given activity. For example, the higher rate of football injuries in males versus females is undoubtedly a function of exposure time, not to some inherently greater sturdiness among females.

The statistic of years of potential life lost (YPLL) is a particularly useful one for making comparisons of problems within a population. This statistic is calculated by summing, across the population, the years between the time of death and a point representing life expectancy or retirement age (Perloff, et al, 1986). For example, if age 70 is defined as the age of life expectancy, years of potential life lost for someone dying at age 16 would be 54. In contrast, someone dying at age 65 would lose only 5 years of potential life. Summing the years of potential life lost for all persons dying in a given year permits comparisons of the relative magnitude of different causes of death in a population.

Mortality Trends:

At the turn of this century, injuries were ranked well below the infectious diseases and heart disease as a cause of death.

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Over the past 80 years, the relative prominence of injuries as a source of mortality in the population overall has changed markedly. As of the mid-1980's injuries are the fourth leading cause of death overall, following heart disease, cancers, and stroke.

--Insert Table 1 about here --

The ~~unintentional~~ injury death rates per 100,000 United States population across the age spectrum are depicted in Table 1. As this figure shows, adolescents have particularly high injury death rates; with death rates of 16.5 and 63.4 per 100,000 for youth ages 10-14 and 15-19 respectively. Only the population over age 65 has comparable rates. It is important, in considering the relative rate of injury death among the elderly as compared to youth, to realize that the case fatality rates (i.e. the proportion of all injuries that result in death) for injury are higher among the elderly. That is, for every elderly person injured, the probability of death is higher than it is for a younger person with the same injuries. Consequently, total injury deaths among adolescents are actually reflective of many more injuries than are the total injury deaths among older persons.

Injuries are the leading cause of death between the ages of 1 and 44 in this country. Among adolescents ages 10-14 and 15-19, injuries account for 58% and 78% of all deaths, respectively. In contrast, for persons between ages 20 and 24 injuries account for 77% of all deaths, dropping to 41% in the 25-44 age group, 6.5% between ages 45-64 and 2% in the over age 65 group (Figure 1).

--Insert Figure 1 About Here--

Furthermore, intentional and unintentional injuries combined far exceed every other cause of death in terms of years of potential life lost (YPLL) before age 65 (Figure 2). In the U.S. population overall, injuries alone account for 40% of all YPLL, far exceeding the figures for cancer and heart disease (National Academy of Sciences, 1985). While cancer contributed, in one year's time, 1.7 million years of life lost and heart disease and stroke combined contributed 2.1 million years, injuries accounted for 4.1 million years of potential life lost. This demonstrates the disproportionate injury mortality among youth.

--Insert Figure 2 About Here--

Morbidity Trends:

Injury deaths are just the "tip of the iceberg." The numbers of nonfatal injuries are much larger. For all ages, the numbers of injuries resulting deaths, hospitalizations and emergency department care are depicted in Figure 3. Data from the Massachusetts Statewide Childhood Injury Prevention Program (SCIPP) indicate that for every adolescent injury death (ages 13-19), there are 41 injury hospitalizations and 1100 cases treated in emergency rooms (Gallagher, et al, 1984). Good estimates of the additional number of injuries treated by private physicians, clinics, athletic trainers, and at home are not available.

--Insert Figure 3 About Here--

Studies in North Carolina and Massachusetts indicate that adolescents experience more injuries requiring hospitalization when compared to other age groups under age twenty. In North Carolina, 15-19 year olds accounted for 44% of all injury-related hospitalizations and close to 10% of hospitalizations from all causes in the under age 20 population (Runyan, et al, 1985). Information about disability associated with injury is extremely sparse. Although not specific to adolescents, data from the 1977 National Health Interview Survey estimates, that the prevalence of disabilities of at least three months duration due to injuries total more than 1.7 million among persons under age 25. As many as 32,000 of these involve paralysis and 198,000 people experienced amputations of limbs, fingers, or toes (National Center for Health Statistics, 1986).

Recent data released as part of the publication, The Cost of Injury, indicate that in 1985 alone there were 464,0078 hospitalized injuries and 12,257 non-hospitalized injuries in the 15-24 age group (Rice, et al, 1989).

According to national hospital discharge data for 1987, the age 15-24 age group is responsible for 26% of all head injuries resulting in hospitalization with rates of injury of 261 per 100,000 population (Foreman, et al, unpublished manuscript, 1989). While an estimated 5-10% of victims die as a result of their injuries, 90% of the victims of head injury do survive. At least 10% of those have long term neuropsychological sequelae (Kraus, in press; Frankowski, 1986; Klauber, et al, 1981). Until recently, milder cases of closed head trauma often have been largely ignored as an injury problem. However, some recent studies have suggested that many of these milder injuries can have long term behavioral

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and neurological ramifications.

Etiology:

Each of the major types of adolescent injury is desribed below, with attention to the associated risk factors (Table 2).

Motor vehicle related injuries can be subclassified as to whether they involve cars, motorcycles, bicycles, or pedestrians. The table shows the average annual number of deaths and death rates among adolescents due to various types of incidents involving motor vehicles.

--Insert Table 2 About Here--

Adolescent drivers are especially vulnerable to fatal crashes at night. On a mileage basis, teenagers do 20% of their driving at night, but suffer more than half of their crash fatalities during nighttime hours. Even taking into account that males drive more than females, the nighttime fatality rates for teenage males exceed those for females by more than two to one (Williams, 1985; Williams, et al, 1983).

Not only do adolescent drivers suffer, but their passengers are also at increased risk. The majority of adolescents killed as passengers are passengers in cars driven by other adolescents. In addition, adolescents are disproportionately responsible for the deaths of other non-adolescent drivers, passengers, and pedestrians (Williams, 1985; Williams, et al, 1983).

Alcohol is an important contributor to the problem. The proportion of fatally injured adolescent drivers who have alcohol in their blood is lower than that for older drivers. However, the

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rate of alcohol involved fatalities on a per mile driven basis is considerably larger among adolescents. In other words, while adolescents are less likely than older drivers to drive after drinking, those who do are subject to a higher risk of being in a crash than are their adult counterparts. In addition, the blood alcohol concentration in the fatally injured adolescent driver is lower, on average, than it is for the fatally injured adult driver. This suggests that it takes less alcohol for the adolescent driver to be at risk for a serious or fatal motor vehicle crash (Waller, et al, 1986; Wagenaar, 1983; Fell, 1984).

A number of studies have documented that adolescents are less likely to use seat belts than are other age groups. The evidence about the efficacy of seat belts is firm (Campbell, et al, 1982; Insurance Institute for Highway Safety, 1989). The failure of adolescents to use seat belts increases their risks of suffering serious or fatal injury in crashes.

Drowning is the second leading cause of unintentional injury death for adolescents, accounting for more than 846 deaths in the 10-19 age group annually, or rates per 100,000 of 1.64 for 10-14 year olds and 3.03 for those between ages 15 and 19. The site of adolescent drowning is usually a lake, river, stream, pond, or canal, rather than either an ocean or a swimming pool (Patetta & Biddinger, 1988; Wintemute, et al, 1987). While the vast majority of drownings occur during the summer months, recreation around cold water, including ice fishing or play on frozen ponds, lakes, and streams is also a concern as submersion in cold water poses the added danger of hypothermia and hinders rescue efforts. Alcohol is involved in close to 40% of adolescent drownings (Patetta & Biddinger, 1988; Wintemute, et al, 1987; Orlowski, 1988; Howland & Hingson, 1988). Alcohol not only influences the judgment of the person in a dangerous situation, but also increases the likelihood of aspiration of water upon immersion. The extent to which swimming competence can reduce adolescent drowning is not known. While it certainly cannot hurt, knowing how to swim undoubtedly is not sufficient to prevent drowning, especially if the potential victim or the potential rescuer is drunk.

Burns and fires are responsible for relatively less mortality among adolescents than in other age groups or than other types of injuries among adolescents. However, in the 15-24 age group in 1985, hospitalized injuries associated with burns and fires totalled 8937 or 23.1 per 100,000 and nonhospitalized burn and fire related injuries occurred at a rate of 931.3 per 100,000, exceeding that of any other age group (Rice, et al, 1989). Much of this morbidity is associated with occupational exposures, as discussed in the occupational injury section of this report.

Sports and recreational activities are leading sources of nonfatal adolescent injury according to data from Massachusetts where they account for one in 14 hospitalized injuries among 13-19 year olds (Gallagher, et al, 1984). Injury rates vary considerably by type of sport or recreational activity, as shown in Table 3 (Zaricznyj, et al, 1980).

--Insert Table 3 About Here--

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Football is one of the most hazardous interscholastic athletic activities, accounting for 28 injuries per 100 participants per year (Torg, et al, 1987; Mueller & Schindler, 1987). Nationwide, the largest share of these injuries are to the knee or ankle, but a significant proportion are to the head and neck where the severity of impairment is likely to be greater. Between 1973 and 1980, 260 high school and college players died from football related injuries. Improvements in helmet design reduced the frequency of head trauma during the late 1960's and early 1970's, but resulted in greater use of the head for blocking. In the early 1970's, this was associated with an increased incidence of neck injuries, including quadriplegia. However, the incidence of permanent quadriplegia declined from an average of 35 cases per year in 1971 to less than 10 per year as of 1986 (Torg, et al, 1987; Mueller & Schindler, 1987). This decrease has been attributed to the 1976 ruling by the National College Athletic Association (NCAA) and the National Federation of State High School Athletic Associations (NFSHSA) which eliminated spearing (using the head to block an opponent while tackling). This form of blocking poses particular risks for intracranial hemorrhage, craniocerebral death, quadriplegia, and other injuries to the cervical spine.

Other organized sports also contribute their share of injuries, with track and field, baseball, and basketball showing the highest rates among the predominantly male sports. In team sports with high female participation, gymnastics poses the greatest risks (Kraus & Conroy, 1984). Interestingly, most sports

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injuries occur during practice rather than in actual competition. While this is certainly a function of the greater amount of time spent training versus competing, it may also suggest problems with training practices.

Other recreational activities that contribute to the adolescent injury problem are bicycling and the use of all-terrain vehicles (ATV's). Bicycling injuries are greatest between ages 5 and 14, with approximately 70% of the 900 bicycling deaths and 550,000 injuries treated in emergency rooms occurring among riders under age 15 (Selbst, 1987). Among youth, the older the rider, the more likely the injury is the result of a collision with a motor vehicle. Crashes involving motor vehicles are more serious, with head injury a frequent and severe outcome. As many as 90% of all bicycling fatalities involve motor vehicles, largely the result of head injuries (Kraus, et al, 1987). For cases requiring hospital admission, there is as much as a five times greater chance that the event involved a motor vehicle (Friede, et al, 1985). Among nonfatal cases, extremity injuries account for over half with head injuries being associated with about a third. Across all age groups over age 14, as many as 65% of the victims of brain injury derived from bicycle crashes were intoxicated (Kraus, et al, 1987). However, testing is not done uniformly and little information exists about exposure to either bicycling or alcohol in the noninjured bicycling population.

All terrain vehicles have become a source of considerable injury and controversy since their introduction into the U.S. in the 1980's. Originally designed as tractors for use in the flat, wet rice paddies of the Orient, these three or four wheel vehicles have been adopted for off-road recreational use with some models capable of speeds as high as 70 miles per hour. Instability of these vehicles, particularly during turns, is a major problem. As of 1985, there had been 238 documented deaths and an estimated 85,900 emergency room cases in 1985 alone (Newman, 1987; American Academy of Pediatrics, 1989). For the three wheel vehicles, 27% of the total cases are between ages 12 and 15, with an additional 35% in the 16-24 age group. The 12-15 age group accounted for 42% of the incidents involving four wheel ATV's while the 16-24 age group accounted for 19%. Males are involved in close to 80% of the cases, most probably a function of increased exposure time.

Injuries from ATV's are primarily the consequence of either hitting an obstacle and/or tipping over. Among all age groups, head injuries are responsible for 70% of the deaths and are the major cause of hospitalization (Smith, et al, 1984; Cogbill, et al, 1986). Helmets are used by fewer than 20% of the victims, despite clear evidence of their potential to reduce the incidence and severity of head injury. Alcohol has been found to be involved in as many as 30% of the cases involving riders over age 16 (Newman, 1987).

Occupationally-related injuries are not well-documented, particularly for adolescents. However, among workers of all ages, injuries account for 98% of all the cases of occupational injury and illness (Kraus, 1985). With approximately 8 million

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adolescents between ages 16 and 19 in the U.S. civilian labor force as of 1986, the opportunities for injury are considerable (U.S. Department of Commerce, 1988).

In the population at large, the occupations with the highest injury fatality rates are mining and quarrying, agriculture, and construction, followed by transportation and public utilities. Motor vehicles are responsible for the largest share of deaths across all industries, though injuries associated with other kinds of equipment and falls as well as violence, are important sources of occupational mortality.

One study in Massachusetts using hospital-based injury surveillance data provides an indication of the risks for adolescents in the workplace. Among the study population, work-related injury accounted for 24% of all injuries to adolescents ages 14-19 for which the location of injury was known. Males were at four times the risk of females and injuries were more frequent in the summer months, when more youth are employed and thereby, exposed to unfamiliar equipment and environments (Anderka, et al, 1985). A Swedish study has documented a higher incidence of injury among working adoelscents compared with both nonworking peers and adult workers (Jacobssen & Schelp, 1988).

Youth who work in retail establishments, especially convenience stores and gas stations, are at risk for shootings. Recent studies in both Texas and California demonstrate that on-the-job homicides accounted for a substantial proportion of all on-the-job deaths (Kraus, 1987; Centers for Disease Control, 1982).

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Adolescents working in both gas stations and restaurants have been shown to be at increased risk of burn injury (Rossignol, et al, 1986; Chatterjee, et al, 1986).

It is estimated that 4000 adolescents between 10 and 19 suffer nonfatal farm-related injuries each year, while an additional 186 are killed. Fatal farm injuries among teenagers occur at a rate of 16 per 100,000 farm residents with the rate for males between 15 and 19 being over 30 per 100,000 farm residents per year (Rivara, 1985). The largest proportion of these fatal farm injuries are associated with machinery, but some result from drowning, suffocation, firearms, or trauma caused by an animal.

Unintentional Firearm Injury: Unintentional firearm injuries primarily involve adolescent males. Three year averages of unintentional firearm death rates (1984-1986) increase from .28/100,000 in children under age 10, to 99/100,000 in early adolescents 10-14 years of age and peak at 1.33/100,000 among 15-19 year olds. Death rates decrease to 1.09/100,000 among 20-24 year olds and continue declining to .57/100,00 in adults over 25 years of age (National Center for Health Statistics, 1984, 1985, 1986).

Unintentional firearm-related death rates among adolescent males exceed rates for females by almost 8:1. In the 10-14 year old age group unintentional firearm death rates are highest among white males (1.93/100,000) followed by black males (0.97/100,000), then white females (0.25/100,000) and rates are lowest among black females (0.23/100,000). In the 15-19 year old age group unintentional firearm death rates are highest among black males

(2.56/100,000), followed by white males (2.31/100,000), then white females (0.28/100,000) and rates are lowest among black females (0.24/100,000) (National Center for Health Statistics, 1984, 1985, 1986).

Since 1970 the incidence of unintentional firearm deaths peaked at 2,618 in 1973 and has declined to 1,452 in 1986 for all ages (Wintemute, 1987). This downward trend in unintentional firearm death rates is also present among younger and older adolescents. National morbidity data specific for nonfatal unintentional firearm injury is unavailable.

CONSEQUENCES

Assessing Injury Costs:

Economic costs associated with a health problem are another way to gauge the magnitude and distribution of the problem. Usually, figures of dollar costs take into account both **direct costs** and **indirect costs**. Direct costs include medical care and rehabilitation expenses while indirect costs also include measures of lost wages and productivity. Information about costs is obtained primarily from health care billing or insurance records.

Cost Trends:

The total dollar costs associated with injuries are enormous. These figures include two components: 1) direct costs associated with medical treatment and 2) indirect costs, which are estimates of foregone earnings. Direct costs are "the amount paid for personal health care...(and) expenditures for home modifications, vocational rehabilitation, and overhead and admnistrative costs for health and auto insurance...(for those injured" (Rice, et al, 1989). Indirect costs can be subdivided into morbidity and mortality costs. Morbidity costs include the valued of goods and services not produced because of injury-related illness and disability; while mortality costs constitute the value of lifetime earning lost by all who are fatally injured and die prematurely.

A recent report to the U.S. Congress documents that injuries cost the American economy $158 billion dollars in aggregate lifetime costs to the 57 million people injured in 1985 (Rice, et al, 1989). Lifetime costs include morbidity and mortality costs.

In 1985, direct costs constituted 29% of the total, or $44.8 billion; morbidity costs were $64.9 billion (41% of the total); and mortality costs totalled $47.9 billion, the remaining 30% of the total $158 billion (Rice, et al, 1989).

For mortality and morbidity costs, males account for more than females and the ages 25-44 experience the greatest losses, followed by the 15-24 age group (Table 4), though persons over age 65 experience the greatest direct costs due to higher rates of hospitalization.

For the age group 15-24, the costs of specific injuries are summarized in Table 4, showing that motor vehicles are the leading cause followed by falls, firearms, poisoning, burns/fires, and drownings.

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RISK FACTORS:

Risk factors are those characteristics of the host, the agent, or the environment that are associated with an increased likelihood of injury occurrence. As with many health problems, it is very difficult to pinpoint the exact contribution of any given factor because very few operate independently. Risk factors in many cases are hard to quantify and interactions between them can influence both injury occurrence and severity. Injuries occur because of interactions among adolescents and the agents or environments with which they come in contact. Risk factors are associated with the demands of particular tasks, the individual's developmental characteristics, as well as peer, family, mass media, and other cultural influences upon adolescent behavior and the injury process. While the specific contributions of some of these elements are not well-researched with respect to injuries, their roles in other aspects of adolescent health can probably be generalized to the injury problem.

The availability of cars that are designed to travel at 120 miles per hour presents a considerable risk for youth. Similarly, the extent to which alcohol is marketed actively to adolescents represents a risk factor imbedded in our culture. These are just two examples of the risk factors inherent in the products and environments that surround us. Efforts to control these kinds of risk factors differ from those directed purely at the adolescent's behavior.

Alcohol use is a major risk factor for all types of injury.

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Alcohol works in at least three ways in the injury process. First, it impairs the functioning of the user in terms of judgment, increasing the probability that the person will become involved in a potentially injury-producing activity or situation (e.g., driving too fast, diving into shallow water, playing Russian roulette). Second, alcohol impairs the ability of the user to perform the tasks necessary to avoid injury (e.g., negotiating a slippery curve, swimming to the shore without aspirating water, exiting a burning building). Third, alcohol serves to exacerbate the severity of whatever injuries are suffered.

Because adolescents typically are not experienced drinkers, small amounts of alcohol can have greater effects than is true for the more experienced drinker. This is evident in the case of motor vehicle crashes.

Gender is a risk factor for injury in adolescence as it is in all other age groups. Although there is some variation by cause, total rates of injury death for 10 to 19 year old males exceed those for females by as much as nine to one, as shown in Table 5. It is impossible to determine the extent to which this pattern is a function of differing exposures to situations where injuries may occur or to differing susceptibility based on some other factor. For example, males drive more than females, even in the teenage years, and they are certainly more likely to play football, and may be more likely to engage in activities that could result in drowning. Being male probably is not per se, what puts teenagers at risk. Rather it appears that males are more likely to engage in more hazardous activities.

Race, like gender, is associated with injury patterns across the lifespan. For unintentional injuries as a whole, the rates for black adolescents exceed those for whites in both age groups. For blacks age 10-14 the rate of unintentional injury deaths is 14.7 per 100,000 compared to 13.0 per 100,000 for whites. For the 15-19 age group, although the overall injury rates (including intentional injury) for blacks are greater than for whites, the rates of unintentional injury mortality are slightly less (49.7 per 100,000 for blacks vs. 25.9 for whites). The differences in rates vary by type of injury.

In the aggregate, both **social class and rural versus urban locale** have been shown to be associated with many types of injuries, but the specific relationships between these factors and injury among adolescents have not been well-described. Certainly the rural environment presents different types of exposure than does an urban setting; for example, the hazards associated with farm equipment versus pedestrians crossing busy streets. People who live in poverty, whether in the rural or urban environment, have greater risk for residential fires, drowning, and motor vehicle related deaths. It has been postulated that there are also social class differences with respect to the selection of specific types of recreational activities and their inherent risks. This is most likely a function both of the costliness of certain sports activities and the socio-cultural norms associated with choosing specific recreational activities.

Risk taking and experimenting are normal developmental components of adolescence as are the processes of achieving autonomy and peer approval. Years ago, the term "accident proneness" was coined in an attempt to define personality attributes of individuals predisposing them to "accidental" or unintentional injury. While there are clearly population groups (e.g., adolescent males) at increased risk of injury, it has not yet been possible to pinpoint specific characteristics of individuals that are associated with particularly high risk. Because the social development and behavioral characteristics associated with adolescent injury are universal, every adolescent should be considred "at risk."

PREVENTION

Obviously injury interventions need to be tailored to the particular problem at hand. Below, specific intervention measures are reviewed as they pertain to some of the major injury problems faced by adolescents.

Motor vehicle injuries can be prevented by a variety of means. One clear intervention that has gained increasing acceptance over the past decade is the use of seat belts. However, because adolescents are more resistant than other age groups to using seat belts, special approaches to encourage adolescents to use seat belts are necessary. There has been at least one successful intervention to increase adolescents' voluntary use of seat belts. A cash incentive program, based in Chapel Hill, North Carolina succeeded in increasing observed use among males from just under

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20% to close to 39% and among females from 21% to 44% over a 4 month period. The program involved soliciting donations from parents and private businesses paired with extensive publicity at the high school. Students' cars, identified by bumper stickers, were stopped randomly by study personnel as they entered the school parking lot and, if the occupants were wearing their seat belts, they were rewarded with $5 in cash. For students not driving to school, their family cars were identified by bumper stickers. When the occupants were observed anywhere in the community to be wearing seatbelts, the youth was rewarded with $5 the next day in school (Campbell, et al, 1982).

Passive restraint devices like airbags or automatic seat belts are becoming increasingly available as a result of federal regulation. These devices are each limited in ways different from standard shoulder-lap seat belts. Airbags, as they are currently constructed, are only effective in frontal collisions, or those that comprise about 35% of fatal car crashes (National Highway Traffic Safety Administration, 1987). Their efficacy can be enhanced by the simultaneous use of manually operated seat belts. While the efficacy of automatic seat belts is somewhat more limited in side collisions than is that of traditional lap and shoulder belts, the use of passive restraints could have a substantial impact on injury reduction because, like airbags, they do not rely upon active compliance.

State laws requiring the use of seat belts have proven to be effective in increasing overall usage in the population. Current

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estimates suggest that in the 32 states with seat belt laws, usage has increased, on average, from 10% to 35% pre-law to, on average, 48% after implementation of the laws (Campbell, et al, 1987). The usage patterns for adolescent drivers are less favorable. Adolescents are less likely to use belts voluntarily and also less likely to comply with seat belt laws than are their adult counterparts (Robertson, 1978; Preusser, et al, 1987).

Other measures that have been shown to be effective in reducing adolescent motor vehicle injuries are nighttime driving curfews, and changes in the drinking and/or driving age. It has been shown that states with nighttime curfews for 16 year old drivers have reduced fatalities in this age group by as much as 69% (Williams, 1985). Since a full 50% of fatal crashes of 16-19 year olds occur between 9 PM and 6 AM, this measure has considerable potential for reducing injury. Drinking age legislation has passed in all 50 states in recent years. In most states, these laws raised the legal age for alcohol consumption to twenty-one. The results from multistate studies clearly indicate that this is an intervention that is successful in reducing fatal nighttime crashes involving young drivers by 12% - 13% (DuMouchel, et al, 1987; Hingson, et al, 1985; Garber, 1988). To reduce alcohol related injuries among the population overall, increasing the tax on alcoholic beverages has also been suggested (Phelps, 1988). The extent to which adoelscent injuries could be reduced by this method is unclear.

It has been suggested that the age of driver licensure be increased so that the individual is more mature before taking on the complex task of driving. This approach does respond to the data which demonstrate a disproportionate involvement of young drivers in severe and fatal crashes. However, the approach does not account for the fact that it takes time and practice to become a proficient driver, even at older ages. In response to this fact, one strategy that has been proposed by Waller, is to develop a "graduated driver licensing system" whereby adolescents may actually start driving as early as age 14, but under close parental supervision. Privileges of driving at night, without parents present, and with any alcohol are phased in over the course of several years. She suggests that this could prolong the time that adolescents are expected to master the task of driving and not force them to master learning to drive and learning to drink simultaneously. Rather, she contends, the two skills would be acquired more gradually, coupled with considerable supervised driving experience (Waller, 1986).

Driver education has long been endorsed as an intervention to reduce teenage morbidity and mortality due to motor vehicle crashes. While completion of such a course has been reported to reduce crash involvement, this effect may be due more to the type of individual who enrolls in driver education courses rather than to the course itself. People who enroll in high school driver training tend to be "better students" and drive fewer miles, characteristics that are associated with lower levels of crash involvement. Controlling for these characteristics essentially eliminates the protective effects of driver education (Lund, et al, 1986). In fact, it has been documented that the greater the availability of driver education, the greater the involvement of teenagers in motor vehicle crashes (Robertson, 1980). This may be the result of larger numbers of adolescents obtaining licenses. Thus, the driver education programs appear to be of questionable value.

Motorcycle helmets are another importance countermeasure. For all ages, helmets could save as many as 28% of the lives lost in motorcycling (Wilson, 1989; Evans & Frick, 1988). Currently, 23 states have full-use motorcycle helmet laws, while an additional 25 have laws requiring helmet use for those under a specified age (often 18 years) (Insurance Institute for Highway Safety, 1989). Although the presence of a law has been associated with an overall decline in motorcycle death rates from 3.63 to 1.07 per 100,000 collisions in Louisiana, the specific effect on youthful riders is unknown (McSwain & Willey, 1985).

Sidewalks, crosswalks, crossing guards and encouragement of adherence to pedestrian safety rules are among the countermeasures for reducing pedestrian injuries (National Safety Council, 1987). As adolescents achieve independence, they are more often out at night and likely to be on foot, especially those younger than 16 years. Adolescents are less likely to use intersection crosswalks or adhere to crossing rules (Jonah & Engel, 1983). Consequently, better understanding of pedestrian behavior, particularly in the 10-14 age group is necessary.

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The prevention of adolescent **drowning** is very difficult. The major success story in drowning prevention is the use of adequate swimming pool fences. This measure has significantly reduced drownings of young children in Australia and Hawaii (Millner, et al, 1980; Pearn & NIson, 1977; Pearn, et al, 1979). However, adolescent drownings occur mostly in natural bodies of water so are not as amenable to this countermeasure (Patetta & Biddinger, 1988; Wintemute, et al, 1987). Reducing the use of alcohol among adolescents may be an effective means of preventing drownings. To date, there have not been any reports comparing drownings in states before and after the enactment of drinking age laws.

It might seem that improvements in the swimming ability within the population would have a favorable impact on the drowning problem. However, there is no evidence of the numbers of drowning victims who knew how to swim, or of the baseline rate of swimming competence in the population.

For those adolescents who drown while boating or fishing, particularly those who have been drinking, the use of appropriate flotation equipment has the potential to reduce mortality. However, voluntary compliance with the use of life vests is unlikely to be high among youth and enforcement of mandatory usage is exceedingly difficult. Although many drownings are witnessed, resuscitation attempts often are not initiated properly or quickly, suggesting the need to improve rescue training (Patetta & Biddinger, 1988; Dietz & Baker, 1974; MacLachlan, 1984).

Sports and recreational injuries are prevented through a variety of means. Changes in blocking and tackling rules and improvements in football helmet design have been helpful in reducing serious head and neck injuries among football players, as noted above. Given that such a large share of sports injuries occur during practice, it is important to have well-qualified trainers and coaches who insure that youth are properly conditioned and that there is appropriate medical backup. While there is limited support for the benefits of pre-participation physicals in reducing sports injuries overall, identification of incomplete rehabilitation of prior injuries may be beneficial (Runyan, 1983; Kraus, et al, 1987).

The use of bicycle helmets has potential to reduce head injury among cyclists. Helmets are relatively ineffective in most fatal crashes, but have considerable potential for reducing the severity of injury in nonfatal crashes. Several studies have indicated that hardshell bicycle helmets could reduce, by as much as 10 times, the incidence of significant injuries (Dorsch, et al, 1984; Wasserman, et al, 1988; Thompson, et al, 1989; Runyan, et al, unpublished). Despite the demonstrated effectiveness, helmet use is low, with estimates suggesting that as few as 10% of recreational cyclists use helmets (Wasserman, et al, 1988; Thompson, et al, 1989). As of 1986, the United States Cycling Federation made the use of hardshell helmets mandatory among all cyclists in sanctioned races, with some spillover of increased use in nonracing situations (Runyan, et al, unpublished). Local school districts could require helmet use on school grounds and could conceivably increasing usage among students in all cycling. This approach has been tried in Australia, with positive outcomes (McDermott, 1985). The provision of bicycle paths, appropriate maintenance of cycling equipment, and efforts such as incentive programs to encourage voluntary helmet use should be considered, although their actual effectiveness has not been tested.

There has been considerable furor over the use of all-terrain vehicles during the past several years. As of March 1988, the Consumer Product Safety Commission instituted a ban on the sale of three wheel vehicles and ruled that the sale of four wheel vehicles must be more closely controlled. In addition, there have been some local efforts to ban the sale of four wheel vehicles on the grounds that they, too, pose significant dangers, particularly to young riders. Since a large proportion of the injuries to ATV users are head injuries, the use of helmets is recommended. As with motorcycles and bicycles, the required use of helmets is likely to result in more widespread protection than is a strategy that relies on voluntary usage. However, there have been no published evaluations of the effects of either the changes in laws regarding sale of ATV's or the effectiveness of helmets in ATV crashes.

The prevention of **occupational injuries** to youth is, of course, dependent upon the type of injury and setting in which it occurs. To a large extent the occupationally-related motor vehicle problem is amenable to many of the same prevention strategies as in nonoccupational settings (e.g. reducing driving hazards). Until more is known about the injury risks faced by adolescents in the

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workforce, few specific recommendations can be made about prevention.

Because agricultural injuries result from many different causes, interventions need to be varied. Some examples include the use of shields or automatic shutoff devices on certain types of farm equipment to protect against limbs getting caught in moving parts or rollover protection on tractors and other riding equipment. Consideration of the appropriate role of youth in farm practices and the need for training to perform certain farming duties could also be more thoroughly addressed.

Little is known about the risk factors associated with **unintentional firearm injury** among adolescents. A study of unintentional firearm fatalities in North Carolina indicates that 28% occurred while the adolescent (15-19) was hunting. Alcohol was found in 18% of the deaths among 15-19 year olds and 44% of deaths among adults over 20 years of age (Morrow, et al, 1986). Another North Carolina study of unintentional hunting firearm injuries found 2 unsafe hunting practices more prevalent among younger victims. Among those injured while hunting, carrying the firearm incorrectly was reported by those 8-19 years of age almost four times as often as reported by adults over the age of 20 (Cole & Patetta, 1989). In addition younger victims of a hunting injury (8-19 years old) were more likely to report that the firearm discharged although the trigger was not pulled.

A study of 88 unintentional firearm deaths among children under 15 years of age in California indicates that older children (those 10-14 years of age) were more likely to be involved in unintentional injuries involving others, whereas among younger children (0-5 years of age) a self-inflicted pattern of injury was more common. Three-quarters of these injuries occurred while the children were playing with the gun. The type of firearm involved in these injuries were as follows: handgun (58%), rifle (27%) and shotgun (15%) (Wintemute, et al, 1987).

IMMEDIATE AND SHORT TERM TREATMENT

Acute and short term health services for adolescents who sustain an unintentional injury are delivered in emergency departments, trauma centers and general hospitals. Emergency medical service systems have been designed to serve adult patients. Trauma centers have effectively decreased mortality from traumatic injury among adults, but a similar effect has not been seen in pediatric patients (ref). Among trauma patients in Los Angeles county, 12% of those 1-19 years of age died in the emergency room or hospital whereas only 7% of those over 19 years of age died (Seidel, 1984). The trauma-related mortality rate during prehospital care, at the scene of the injury and en route to hospital, is almost twice as high among children as adults (Seidel, 1986). — Table 6 —

Regional data from the Northeastern Ohio Trauma study examined emergency room visits indicate that the rates of motor vehicle-related injury presenting to emergency departments are also highest among 15-24 year olds (4,900/100,000) and that 9% require hospitalization (Fife, at al, 1984). Poisonings requiring hospitalizations were highest among older adolescents and young adults (15-24) as well as the very young (ages 0-4).

In addition to the rate of hospitalization, data on the length of hospitalization illustrates health service needs of special populations. The Massachusetts Statewide Childhood Injury Prevention Program examined injury-related hospitalizations among 0-19 year olds and found that the median length of stay was 1.9 days, with a range of 1-42 days. Teenagers between ages 13 and 19 had the longest mean length of stay (2.4 days) (Gallagher, et al, 1984).

Little is known about the incidence of minor injuries which are treated in clinics or physician offices, or are untreated. Estimates of trauma-related visits to physician offices among adolescents range from < 2% (Cypress, 1984) to 9% (Yunker,1988). Free standing emergency centers (FEC's) are extended hours clinics serving patients who are insured or pay for services. One study of the use of these centers by adolescents indicate that 36% of the visits by adolescents are trauma-related (Yunker, 1984).

Estimates of the number and rate of minor injuries either requiring medical attention without hospitalization or at least one full day of restricted activity are described using the National Health Interview Survey for 1984-86. The rate of motor vehicle-related minor injuries is highest among older adolescents and young adults (4,086/100,000 15-24 year olds) followed by young to middle aged adults (2,556/100,000 25-44 year olds) and older adults (1,579/100,000 45-64 year olds).

A severely injured child cannot be effectively treated as "a little adult." Although the age at which a child can effectively be treated as an adult is not established, at least for the younger adolescents, those under 15 years of age and perhaps older adolescents who are less physically mature, these principles are warranted. Such a child has special treatment needs. Children have fragile compensatory mechanisms for volume loss, drifting into shock with little to no warning. Their response to drugs and the types of injuries they experience differ from those of adults. On the scene, transport and emergency department care-givers need specialized training in pediatric care and acute care facilities require equipment and back-up services designed for pediatric trauma.

The amount and pattern of trauma injury differs by age. Data from 88 Los Angeles emergency departments indicate that 28% of all trauma cases involved children 1-19 years old (Seidel, 1984). Older children, 13-19 had twice the number of trauma injuries (67%) compared to children under the age of 13 (33%). However this study did not differentiate intentional injury, which is known to be more common among the older adolescent age group. The pattern of injury seen among 1-19 year olds differed from that seen among adults in that trauma injuries in children were more likely to be head trauma (40%) followed by abdominal (20%), chest (15%) and orthopedic (13%). Adults were more likely to have an abdominal injury (38%) followed by head trauma (24%), and chest or orthopedic (19% each).

(Seidel, 1984).

Deficiencies of appropriate equipment for pediatric patients is suggested in surveys of paramedic units in Fire Departments and EMS throughout the US (Seidel, 1986). Over 60% of these prehospital care systems did not have a pediatric backboard and 52-98% did not have appropriate equipment to measure blood pressure.

OPPORTUNITIES FOR CHANGE

General principles:

Because injuries result from the complex interactions of the agent (energy), the human host, and the physical and social environments, there are multiple approaches to prevention and multiple potential targets of change. One schema for conceptualizing the possibilities for prevention is the Haddon Matrix. This matrix combines the public health model of agent-host-environment interaction with the stages of primary, secondary, and tertiary prevention and serves as an extremely useful framework for conceptualizing possible intervention options. The agent-host-environment model serves to identify the elements of the injury process and the possible targets of intervention.

Just as interventions can be targeted at several elements, they also can be directed at several stages of the injury process: pre-event, event, or post-event. These parallel the public health concepts of primary, secondary, and tertiary prevention. Pre-event strategies are those that have their effect before the initiation of the injury-producing event. For example, reducing drinking among adolescents is a pre-event strategy in that it prevents the crash event or shooting event from occurring. Event strategies are those that are directed at reducing the effects of the event during its occurrence. Seat belts help protect occupants in crashes. Post-event strategies are directed at reducing the longer term effects of the injury event after it has happened such as through the provision of timely and appropriate first aid or medical services.

The Haddon Matrix combines these concepts of targets of intervention and phases of interventions. By considering interventions directed at each combination of target and phase, one can think of myriad possibilities. As an example, Figure 6 is a completed matrix showing some interventions pertinent to drowning.

--Insert Figure 4 About Here--

Types of Interventions:

Generating ideas about prevention options is only a part of the task. Deciding which interventions to pursue and how to evaluate them is, in many ways, much more difficult. When using the Haddon Matrix to generate ideas about possible interventions, it becomes clear that there are many ways to intervene. They encompass efforts applied in clinical settings and in schools as well as changing public policies. The types of interventions can be classified into four broad areas: **education, regulation, legislation and litigation.**

Educational efforts might be directed at many different audiences including the adolescents themselves, parents, teachers, manufacturers, and policy makers. For example, education could be directed at convincing adolescents to use their seat belts; parents could be taught how to discuss seat belt use with their children; manufacturers could be educated about the public views regarding seat belt design; and policy makers can be educated about the projected effectiveness of a law requiring seat belt use.

It should be recognized, though, that educational approaches directed toward the individual at risk have traditionally been the least effective means of reducing injury. As with other issues in compliance, there are multiple reasons why a given set of recommendations may or may not be adhered to. These include: 1) the complexity of following the recommendations (how difficult is it to make a safe turn on an ATV); 2) the frequency with which the task is required (the helmet must be remembered and used each and every time); 3) the unpleasantness of the regimen (how hot and uncomfortable is the helmet).

In contrast to voluntary efforts that rely on education to promote compliance, **regulatory measures** typically are directed at changing the environment or consumer products. These regulations are frequently intended to provide passive protection by making changes that do not require individual action. For example, Federal regulations require a wide array of safety features on cars (shatter-proof windshields; collapsible steering wheels; or more recently, passive restraints such as airbags or automatic seatbelts). Similarly, numerous aspects of highway design are the result of regulations in the physical environment.

While regulations are imposed by governmental agencies vested with regulatory authority by Congress or state legislatures, other measures are directly mandated by **legislative action**. Legislative measures are usually directed at changing either the environment or at requiring specific behaviors. Examples include the motorcycle helmet and seat belt laws currently in effect in most states; or local ordinances concerned with swimming pool fencing or the purchase of firearms.

Litigation has been used successfully in some instances to bring about community-wide reductions inthe risk of injury. Primarily this has involved product liability claims directed at product manufacturers. Examples include: 1) efforts to hold handgun manufacturers accountable for the foreseeable harm associated with their product, 2) lawsuits against toy manufacturers for the hazardous nature of some of their products, and 3) suits against communities that fail to maintain playgrounds in safe condition. At times, the threat of litigation serves as an impetus for voluntary changes.

Barry categorizes intervention options according to the extent to which they are active versus passive and voluntary versus mandatory. Figure 5 provides an example of a completed matrix. Active measures require action on the part of individuals in

--Insert Figure 5 about here

in order to afford protection. In contrast, passive measures are those that are put into place, either in terms of product design or general environmental modifications. Mandatory measures are those that are required by legislative or regulatory authority, while voluntary measures rely on the cooperation either of individuals, product manufacturers, or institutions. In general, mandated, passive measures are the most effective. Those relying on voluntary, active participation by the person at risk are least effective for all the reasons mentioned with regard to compliance. Measures directed at mandating behavior have some promise, although they are dependent upon the motivations of the at-risk population to comply with the law as well as the stringency of the enforcement system. Not surprisingly from a development perspective, the willingness of adolescents to comply with some required safety behaviors (e.g., seat belt use) has been demonstrated to be less than that of the adult population. Voluntary measures directed at passive improvements also are of moderate effectiveness. Such an example would be the parent's voluntary installation of passive seat belts in the car driven by the adolescent.

There are a number of factors that enter into the decision making process for the legislator. These factors have to do with balancing the tradeoffs inherent in any kind of choice. Individual freedom is valued highly in our culture. Freedom is compromised by any mandatory measure, yet the gain in overall effectiveness of the measure may be deemed worth the loss in freedom. For example, limiting freedom to ride a motorcycle or bicycle without helmets balanced against the reduction in serious and fatal head injury and the costs associated with them may be judged appropriate.

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Similarly, there are concerns about equitable treatment of those being protected. One example is the concern raised about increasing the drinking age or having differential punishment for drunk driving among adolescents versus adults. While the policies may be unequal, some would consider such a policy equitable as a means to compensate for the unusually high risk among youth; others would consider it discriminatory and unjustifiable. Certainly the costs of interventions are an important consideration, but they must be weighed against the cost savings associated with the intervention's effectiveness in reducing death, injury, or long term disability and all the inherent social and economic effects of those injuries. The balance of these issues will vary depending on the injury problem and intervention options that are available. In their roles as private citizens and community leaders, health professionals need to be aware of these issues and use their knowledge to help clarify the tradeoffs in taking differing approaches to injury problems.

CONCLUSIONS

Deciding what interventions to try and evaluating their effectiveness requires good data. Data are needed to justify attention to the problem and the targeting of intervention resources to the appropriate population groups or settings. Evaluation is essential to determine if interventions are working and to differentiate among the relative merits of the various approaches to reaching the desired goal.

Evidence about the cause of injury is essential for determining appropriate interventions. While diagnostic information helps distinguish skull fractures from concussions or lacerations from contusions, it does not identify factors pertinent to the prevention of the injury. Rather, data about injury causation is essential to differentiate whether the skull fracture resulted from a fall from scaffolding, a motorcycle crash, or from playing football. Each causal factor requires a different solution. In order to be useful, this information must be included in the medical record.

To monitor the injury problem adequately and be able to define appropriate countermeasures requires data collection about the full spectrum of injuries. The recent trend to develop trauma registries has focused on collecting information about only the most severe cases. In fact, many trauma registries are developed with the expressed purpose of monitoring the quality of care in trauma centers. While this is undeniably an important issue, the data are insufficient to guide prevention planning and may, in many instances, be insufficient to address adequately the quality of care questions as well.

A good data system must account for the selection associated with who is triaged to which hospitals. It may be, for example, that in some locales burn cases go to the nearest hospital while in other locales they are taken directly to burn centers. If these facts are not considered, the survival patterns for patients in the two areas may be considerably different, yet the reasons may be misattributed to other characteristics of the care received. Data systems must also include information about the whole spectrum of injuries, and not just those cases that are the most severe; that is, cases admitted for treatment in tertiary care facilities. By definition, injuries treated and released from emergency rooms are not considered. However, this introduces a bias not only because the majority of cases are missed, but also because those may, in fact, represent a different pattern of injury than the cases requiring hospitalization. Just as it is clearly inappropriate to assume that patterns of death are similar to patterns of nonfatal injury, it is also inappropriate to assume that patterns of injuries treated in emergency rooms parallel those requiring admission to the hospital. For example, car-bicycle collisions are more likely to result in serious injury requiring hospitalization, while bicycle crashes not involving motor vehicles are generally less serious. Focusing only on hospitalized cases could potentially lead to conclusions about countermeasures aimed only at reducing car-bike crashes. In contrast, including the less serious cases could suggest other interventions that might have an impact upon a considerably larger pool of bicycle crashes.

Another injury data issue is the measurement of exposure. This is a difficult task and typically requires data collection outside the health care delivery system. For example, in making adequate conclusions about the risk of motor vehicle crashes involving adolescent drivers, it is important to document both the numbers of adolescent drivers and the extent to which they drive. This kind of exposure information serves as the denominator in

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calculating rates. It allows comparisons that take into account whether adolescents contribute disproportionately to motor vehicle crashes or become involved in crashes at rates no different from their parents. Data from transportation or insurance authorities can be obtained to document the numbers of licensed drivers and, in some cases, estimate the numbers of miles driven by the those drivers. However, this kind of exposure information is not available for most other types of injuries. For example, it is unknown how many people know how to swim or do swim; how much time or how many miles are logged on bicycles or all-terrain vehicles; or how ownership of handguns is distributed among the population.

Other data needs include information pertaining to long term outcomes and the costs associated with injury. Documenting outcome requires a record-keeping system with the ability to track injured patients over time and through various systems of health care, educational and rehabilitation services. To be able to document cost, there need to be options for linking data from the health and other service delivery systems with insurance records. Provision of the kinds of identifying information necessary to accomplish either linking or tracing is sometimes resisted because of fears of compromising confidentiality of either patients or health care providers. Both tracing and record linkage have been done in many settings without jeopardizing confidentiality. In any such deliberation, the gain in the ability to fully understand the injury problem and its consequences needs to be carefully weighed in the equation.

Preventive Services:

Unfortunately, less is known about preventive programs for reducing adolescent injury than one might hope. There have been few good studies of specific interventions or intervention approaches. Funding for injury prevention is scarce and has not been sufficient to permit well-designed intervention trials or solid evaluation studies. The new initiatives within the Centers for Disease Control to fund research and intervention programs are directed, in part, at meeting this need. However, funding for this program is minimal in proportion to the magnitude of the problem and programs for other health problems.

The recent publication, Injury in America: Meeting the Challenge (1989), outlines the state of the art with respect to injury prevention. It is striking in this book how few interventions have been well-evaluated, although many appear to be good ideas. There is an urgent need for support of good studies to document the effectiveness of specific interventions of factors associated with intervention modalities.

A number of intervention research questions are presented in a recent publication of the Journal of the American Medical Association (Runyan and Gerken, 1989). The article stresses the importance of understanding adolescent attitudes and beliefs about injury problems and various modes of injury prevention as well as examining the potential effectiveness of specific injury prevention activities (e.g. swimming instruction, mandatory or voluntary use of seat belts, bicycle or motorcycle helmets or flotation devices).

Treatment Services:

Efforts at improving pre-hospital and acute care management are necessary in order to decrease the mortality and morbidity rate and need for long term rehabilitation among adolescents who sustain an unintentional injury. Improvements in pre-hospital and acute care management should include: 1) early identification of an injured person and appropriate treatment site (communication and rapid/safe transport systems); 2) appropriately trained and equipped first responders; 3) experienced team and appropriate back-up facility.

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ACKNOWLEDGEMENTS

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Table 1

Deaths and Death Rates per 100,000 Population Due to Injury
By Age Group, U. S., 1950 vs. 1985 *

Group	Children	Adolescents			Adults
Age	0 - 9	10 - 14	15 - 19	20 - 24	25+
Injury Deaths 1950	11,673	2,620	5,903	8,616	87,564
Injury Deaths 1985	6,603	2,821	11,786	17,665	106,773
Death Rate/100,000 1950	39.75	23.56	55.60	75.04	99.37
Death Rate/100,000 1985	18.95	16.50	63.41	83.27	72.37

* Injury deaths abstracted from NCHS Vital Statistics (E800 - E999) for 1985 and 1950.
Population data abstracted from Bureau of the Census estimates.

Sources:

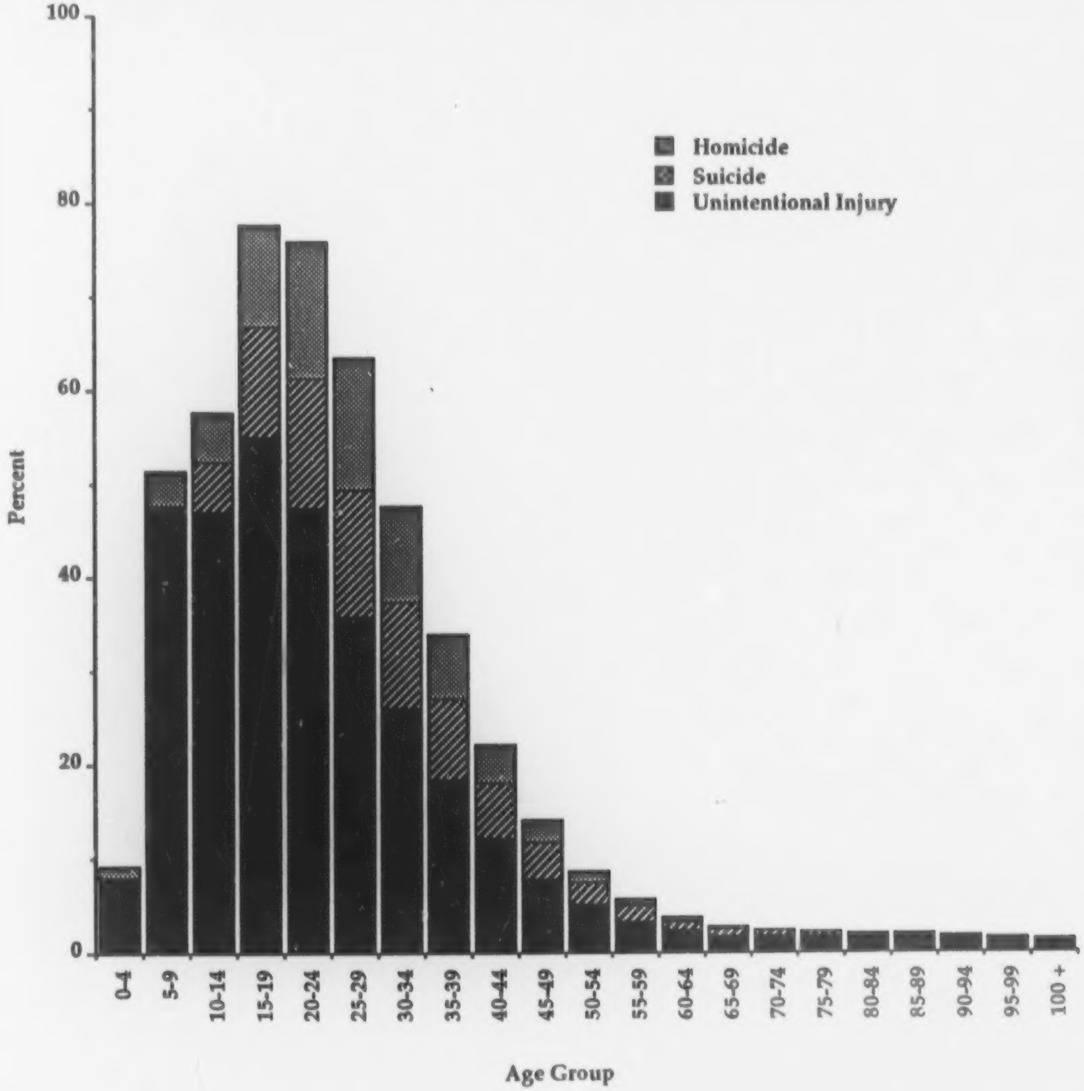
NCHS, Vital Statistics of the U.S., Vol. 2, Mortality, Part A. Washington, D.C.: U.S. Government Printing Office, 1985.

NCHS, Vital Statistics of the U.S., Vol. 3, Mortality Data. Washington, D.C.: U.S. Government Printing Office, 1950.

NCHS, Vital Statistics Rates in the U.S., 1940-1960. Washington, D.C.: U.S. Government Printing Office, 1968.

U.S. Bureau of the Census: Current Population Reports, Series P-25, No. 1000, Estimates of the Population of the United States by Age, Sex, and Race: 1980-1986. Washington, D.C.: U.S. Government Printing Office, 1987.

Figure 1: Average Annual Percentage Total Death Due to Injury by Five Year Age Groups, United States, 1984-1986.



Source: NCHS, Vital Statistics of the U.S., Vol. 2, Mortality, Part A.
Washington, D.C.: U. S. Government Printing Office, 1984 - 1986.

Note: Deaths with age not stated are excluded. Injury death cause undetermined is also excluded and does not exceed 1.6% of total death for any age group.

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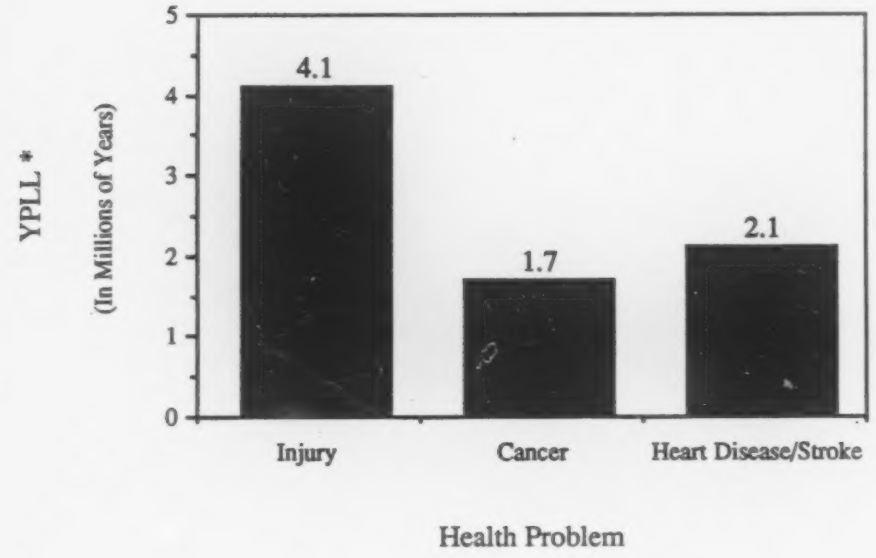
Figure 2: Years of Potential Life Lost Before Age 65 for the Leading Causes of Death, United States, 1982



* Years of Potental Life Lost before Age 65

Source: National Academy of Sciences (1985). Injury in America. Washington, DC: National Academy Press.

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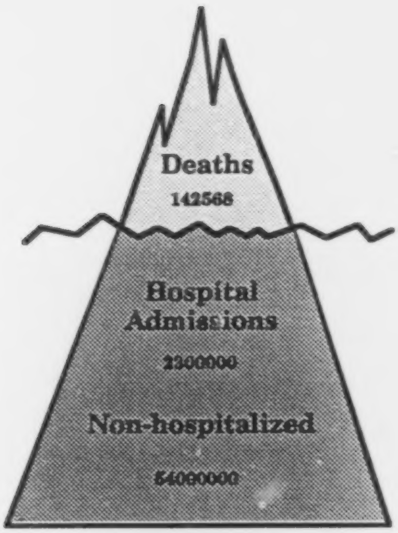
Figure 3: The Injury Iceberg, Total Injuries, United States, !985 *


Deaths
142568
Hospital Admissions
2300000
Non-hospitalized
54000000

The Injury Iceberg

In 1985, for every death there were 16 hospital admissions and 379 nonhospitalized injuries.

Source: Dorothy P. Rice, Ellen J. MacKenzie, and Associates. Cost of Injury in the United States: A Report to Congress. San Francisco, CA: Institute for Health and Aging, University of California and Injury Prevention Center, The Johns Hopkins University, 1989.

Figure 4

Basic Haddon Matrix for Generating Countermeasures

FACTORS

PHASES	Human	Energy Vector	Physical Environment	Social Environment
Pre-Event	• train people to drive defensively • encourage adherence to speed limits	• limit maximum speed of vehicle	• provide adequate lighting and signing on all roads	• discourage or prohibit alchohol use and driving while intoxicated
Event	• teach correct use of seat belts for all drivers / passengers	• provide airbags and other crash protection devices in vehicles	• install energy - absorbing signposts and guard rails	• require use of motorcycle helmets and seat belts
Post-Event	• teach techniques for exiting a burning vehicle	• limit flammability of vehicles	• provide close, available medical emergency care • provide rapidly responding, well trained emergency personnel	• ensure access to emergency medical care for all categories of people, regardless of insurance coverage

Figure 5

The Barry Model for Sorting Countermeasures

	Active	Passive
Voluntary	• taking a driver safety training course • extinguishing cigarettes before going to bed	• purchasing air bags • installing a smoke detector
Mandatory	• seat belt and child safety seat laws • regulations prohibiting smoking on airplanes	• passive safety belt systems • building codes which require smoke detectors in homes

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Table 2
Average Annual Adolescent Injury Deaths and Death Rates by Cause and Age Group, U. S., 1984-1986

	Age 10-14		Age 15-19	
	Deaths	Rate (per 100,000)	Deaths	Rate (per 100,000)
UNINTENTIONAL				
Motor Vehicle Occupant	458	2.69	3,770	20.18
Drivers	56	0.33	2,094	11.21
Passengers	402	2.36	1,676	8.97
Motorcycles	87	0.51	639	3.42
Pedestrians	294	1.72	515	2.76
Bicycles	219	1.28	142	0.76
Other & Unspecified MV	203	1.19	1,526	8.17
Drowning	280	1.64	566	3.03
Firearms	169	0.99	248	1.33
Fires/Burns	174	1.02	238	1.27
Falls	39	0.23	143	0.77
Other Unintentional	324	1.90	752	4.02
Total Unintentional	2,248	13.18	8537	45.69
INTENTIONAL				
Suicide	250	1.47	1,812	9.70
Homicide	256	1.50	1651	8.84
Other Intentional [a]	---	---	25	0.13
Total Intentional	507	2.97	3,488	18.67
AVERAGE ANNUAL TOTAL [b]	2,796	16.39	12,171	65.13
AVERAGE ANNUAL POPULATION	17,059,000		18,686,000	

[a] Other Intentional Injury Deaths for age 10-14 is less than 1 per year (rate/100,000 less than 0.01).

[b] The cause of injury death is undetermined in approximately 1.5% of all injury deaths in each age group (Age 10-14: 42 deaths/year; rate = 0.25/100,000. Age 15-19: 145 deaths/year; rate = 0.78/100,000.). These figures are included in the Average Annual Total.

Sources: **U.S. Bureau of the Census: Current Population Reports. Series P-25. No. 1000. Estimates of the Population of the United States by Age, Sex, and Race: 1980-1986. Washington, D.C.; U.S. Government Printing Office, 1987.**

NCHS, Vital Statistics of the U.S., Vol. 2, Mortality, Part A. Washington, D. C.: U.S. Government Printing Office, 1984-1986.

Table 3

Number and rate of injury in organized school sports, Springfield, Illinois, 1974–1975ᵃ

Sport	No. injuries per activity	No. of participants	Rate/100 participants	Rate/1000 participant hr
Football	126	445	28.3	1.0
Basketball	29	283	10.2	0.3
Baseball	13	137	9.5	0.5
Wrestling	27	165	16.4	0.5
Gymnastics	2	15	13.3	0.4
Volleyball	4	105	3.8	0.1
Swimming	2	74	2.7	0.0
Track & field	23	289	7.9	5.7
Field hockey	2	65	3.1	0.1
Golf	—	—	—	—
Tennis	1	108	0.9	0.0
Cross-country	—	—	—	—
Badminton	—	—	—	—
All sports	229	1894	12.1	

Source: Zaricznyj, B., Shattuck,L.J., Mast, T.A., Robertson, R.V., D'elia, G. 1980. Sports related injuries in school-aged children. Am. J. Sport Med. 8:318-24

Permission for the use of this table needs to be obtained.

Table 4: Lifetime Costs* of Injury for Selected Causes by Type of Cost for Ages 5 -14 and 15 -24, 1985

	Amount (millions)				Cost per Injured Person			
			Indirect				Indirect	
	Total	Direct	Morbidity	Mortality	Total	Direct	Morbidity	Mortality
Ages 5 - 14								
Motor Vehicles	$3,107	$817	$1,553	$737	$9,485	$2,512	$4,775	$264,858
Falls	2,626	1,042	1,556	29	1,057	420	626	165,944
Firearms	293	38	48	207	12,087	1,606	2,039	268,924
Poisonings	108	77	0	30	405	291	0	321,663
Fires/Burns	267	80	42	144	1,583	478	252	296,928
Drownings/ Near Drownings	201	8	2	190	159,021	11,270	3,720	323,347
Other Injuries	3,097	1,964	865	268	448	284	125	243,540
Ages 15 - 24								
Motor Vehicles	$16,107	$3,890	$5,259	$6,957	$9,135	$2,224	$3,007	$401,696
Falls	6,456	1,006	5,170	280	3,538	551	2,834	235,831
Firearms	4,204	365	394	3,445	69,720	6,834	7,372	468,860
Poisonings	1,484	321	429	734	10,839	2,370	3,167	483,760
Fires/Burns	785	155	417	212	2,118	420	1,128	479,831
Drownings/ Near Drownings	767	11	28	728	351,406	15,023	38,738	498,496
Other Injuries	9,340	3,187	4,028	2,125	1,087	371	469	460,224

* Costs discounted at 6 percent.

Source: Dorothy P. Rice, Ellen J. MacKenzie, and Associates. Cost of Injury in the United States: A Report to Congress. San Francisco, CA: Institute for Health and Aging, University of California and Injury Prevention Center, The Johns Hopkins University, 1989.

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Table 5

Male:Female Ratios of Injury Deaths by Selected Causes and Age Group, U. S., 1980-1982

Cause	Age Group 10 - 14	 15 - 19
Motor Vehicle Occupant	1.4:1	2.4:1
Motorcycles	6.2:1	8.0:1
Pedestrians	1.7:1	2.6:1
Fires and Burns	1.4:1	3.1:1
Falls	2.6:1	6.9:1
Drowning	4.7:1	9.9:1
Firearms - Unintentional	6.8:1	8.7:1
Suicide	3.4:1	4.4:1
Firearms	2.8:1	5.0:1
Homicide	1.2:1	3.4:1
Firearms	1.9:1	5.2:1

Will be updated to 1984-1986 data.

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TABLE #6 Unintentional Injury Hospitalizations U.S. - 1985

Age	Injury type	Number	Rate/100,000 persons
0-4	Motor vehicle	8,853	49.2
5-14	Motor vehicle	42,277	124.6
15-24	Motor vehicle	164,892	425.4
25-44	Motor vehicle	185,156	253.9
45-64	Motor vehicle	77,590	172.8

0-4	Poisonings	24,986	138.8
5-14	Poisonings	11,132	32.8
15-24	Poisonings	50,386	130.0
25-44	Poisonings	66,942	91.8
45-64	Poisonings	31,223	69.6

0-4	Burns	11,885	66.0
5-14	Burns	4,940	14.6
15-24	Burns	8,937	23.7
25-44	Burns	16,119	22.1
45-64	Burns	7,818	17.4

0-4	Falls	34,944	194.2
5-14	Falls	59,697	176.0
15-24	Falls	52,363	135.1
25-44	Falls	124,131	170.2
45-64	Falls	143,156	318.9

Source: Rice, et al, 1989

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